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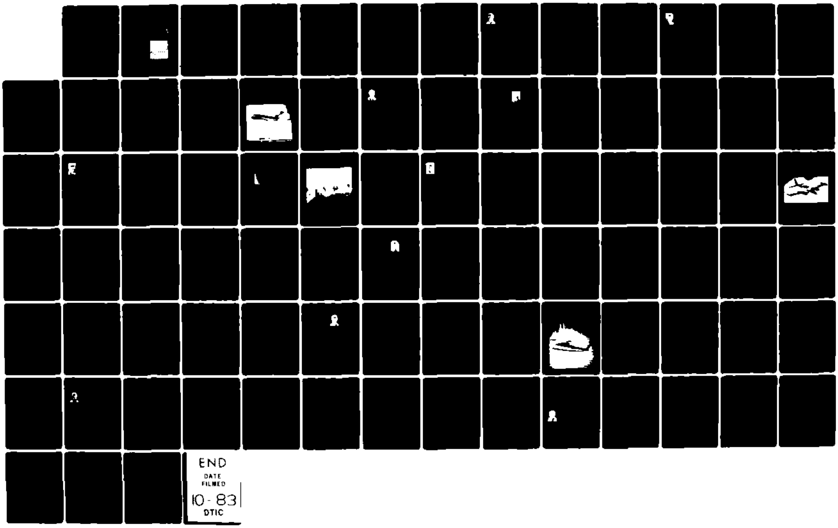

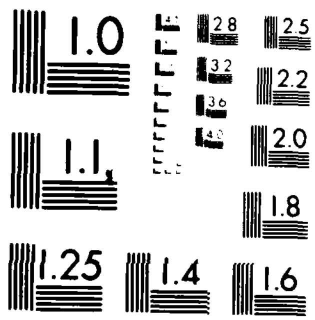

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Federal Aviation Administration

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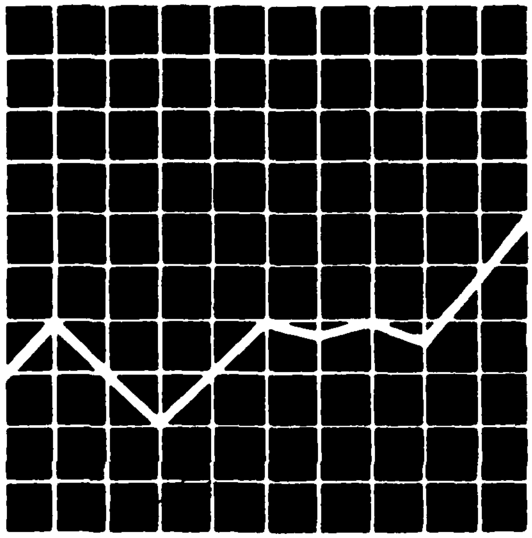
Eighth Annual FAA Forecast Conference Proceedings

February 1983

FISCAL YEARS

1983-1994



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Office of Aviation Policy and Plans • Washington, D.C. 20591

EIGHTH ANNUAL FAA FORECAST CONFERENCE PROCEEDINGS

FEBRUARY, 1983

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
OFFICE OF AVIATION POLICY AND PLANS
WASHINGTON, D.C. 20591

TABLE OF CONTENTS

PROCEEDINGS OVERVIEW

The Eighth Annual Aviation Forecast Conference was held on February 24, 1983, in Arlington, Virginia. The general theme of the presentation was "Aviation-Forecasting: The State of the Art." The speakers addressed the problems associated with and the expectations of aviation forecast methodologies and their impact on the aviation industry. It was generally agreed that the key problem areas center on economic fluctuations and the need to continue to improve and refine the mothodologies used in aviation forecasting.

The keynote address was delivered by Michael Fenello, Deputy Administrator of the Federal Aviation Administration. He was introduced by Thomas Messier, Deputy Director of the Office of Aviation Policy and Plans, who presented an overview of the forecasts.

Following the overview presentation, there was a panel discussion of the forecasting models employed by some air carriers. Robert Bowles, Aviation Industry Analyst, was the panel moderator. The panel members were:

Dr. Paul Biederman, Manager-Forecasting, Trans World Airlines
Mr. David Keith, Director-Aviation Data Bases, I.P. Sharp
Mr. William Dickens, Supervisor of Commercial Market Research, Pratt & Whitney

Dr. Michael Evans, Chief Economist, McMahon, Brafman, Morgan & Co., was the luncheon speaker. He addressed the impacts of economic fluctuation on the aviation industry.

The second panel was moderated by Dr. Arnold Schwartz, Industry Economist. The panelists addressed general aviation forecast models. The panel members were:

Dr. Gerald Fairbairn, Associate Professor of Aeronautics, San Jose State University
Ms. Rosalyn Shirack, Transportation Economist, Oregon Department of Transportation
Mr. William Tucker, Director, Statistics and Forecast Air, Department of Transport Canada

The third panel moderator was Mr. Thomas Henry, Industry Economist. Mr. Henry's panel addressed helicopter forecast models. The panel members were:

Mr. William J. Yates, Manager, International Plans and Programs, Bell Helicopter Textron
Dr. Benjamin Loret, Vice President, Applied Systems Institute
Mr. Jack L. Thompson, Aviation Representative, State of Ohio
Mr. David Lawrence, Director of Strategic Planning, Sikorsky Aircraft

INTRODUCTORY REMARKS

THOMAS MESSIER

MR. MESSIER: My name is Tom Messier. I am currently the Deputy Director of the Office of Policy and Plans at FAA and I would like to welcome you to this, the Eighth Annual Aviation Forecast Conference. Don Segner, notably absent on my far right, unfortunately has been very ill recently and he is unable to be with us today. So I am not only pinch-hitting for Don but I'm also pinch-hitting in terms of giving the major speech this morning for Harvey Safeer. He is currently out of the country. We, here at FAA, have always enjoyed and profited from these annual interchanges of ideas and information between industry and government. Certainly, in these times of economic uncertainty, I think that it is important that together we map out a clear course for the safe and efficient use of our nation's airports and airways systems. In this regard, I am pretty sure you are going to find the discussions we will have this morning of our latest forecasts quite informative, as well as the technical sessions themselves. Since the state of the economy is one of the key driving forces for aviation growth, I think you will be particularly interested in the information that Dr. Michael Evans will pass on to us as our luncheon speaker today. But to start off the proceedings this morning, it gives me great pleasure to introduce to you Mr. Michael Fenello, our Deputy Administrator, who is going to give us some insights into the initiatives FAA has taken to meet the forecasts of aviation growth and the changing needs of our aviation industry. So without any further ado and with great pleasure, ladies and gentlemen, Mike Fenello, Deputy Administrator.

KEYNOTE ADDRESS

Michael Fenello
Deputy Administrator
Federal Aviation Administration

Thank you, Tom. Staff meetings lately at the FAA have turned out to be more like sick calls with the number of people we have had out. When Don Segner and Harvey Safeer asked me to do this, they had just one admonition and they said, "Keep it short." I said, "Well, I'll keep it short but what do you propose I talk about?" They said, "Tell them all you know about forecasting," which is obviously very little. But the turn out this morning is a good indication that there is widespread interest in the subject of our discussions today. All of us involved in aviation are vitally concerned about the economic viability of our industry in the years ahead.

Forecasting, of course, is a particularly precarious undertaking and at the same time it becomes increasingly important and necessary in our complex economic and social structure that we pay close attention to what we know about it and how we go about it. No organization can plan effectively without having some kind of handle on the future. Still one of the worst mistakes any organization or individual can make is to accept any set of forecasts as gospel. Forecasts can be useful tools but only if one understands what the numbers mean and where they come from. I suppose you could say, in a nutshell, that is the purpose of this meeting.

I am going to resist the temptation this morning to highlight the forecasts or get into the nuts and bolts of forecasting methodology. In past years, I have been told, the keynote speaker always stole the best material and left the other speakers high and dry. So I'm going to be a nice guy and leave all the good stuff for those who follow me. Since Lynn Helms put me in charge of the agency's human relations program, I have been trying to set a good example.

However, I do want to point out that our new forecasts reflect the progress we have made in rebuilding the air traffic control system. Indeed, we have achieved sufficient capacity so that strike related restrictions no longer are a significant factor in our projections. We will be back to pre-strike level of 85,000 plus daily instrument operations by the end of April; we still will be using flow control and other measures to prevent overloading of key facilities during peak periods. Paradoxically, the system has grown even while it was constrained. As you probably know, we recently announced the schedule for lifting the remaining flight restrictions. Most of them will be phased out at the enroute centers by fall and we should drop the flight quotas at all but maybe five or six airports by December.

From the carrier's point of view, the ATC system essentially will be back to normal by the end of the year. From FAA's point of view, we expect to be back to the internal normal, whatever normal sometimes is, levels by July, 1984. That means that our controllers will be working traffic, our supervisors will no longer be working traffic but will go back to normal duties and everyone will be getting their desired vacation and holiday leaves.

Another point I would like to make is that in rebuilding the ATC system we have not ignored or neglected the future, quite the contrary. Our number one priority at FAA under Lynn Helms has been to plan for tomorrow's system - five, ten, twenty years down the road. That was true before August 1981, and has been no less true after that time.

Our own and industry forecasts of aviation growth have been a driving force behind this planning effort. We know we cannot handle the projected traffic loads without a major upgrading and modernization of our air traffic control and air navigation system. Simple economics dictate that we proceed with this program as a means of reducing our operational overhead.

All of you, no doubt, are familiar with our National Airspace System Plan, which was issued just about a year ago. It was a detailed 450 page blueprint for updating our facilities and equipment, such as ATC computers, radar, communications systems, navigation, and landing aids and the flight service station system. It has been characterized as one of the most comprehensive plans ever put together by a government agency.

We are in the process now of updating and fine tuning that plan to reflect the developments of the last twelve months. We are dealing really with a galloping technology. Perhaps the major development was the passage last August of the Airport and Airway Improvement Act, along with companion legislation, which provide the means to pay for these improvements through a schedule of user fees. Moreover, we already have begun moving on the key elements of the National Airspace System Plan. For example, a request for proposals - RFP's we call them - was issued for the new host computer at the end of December and the responses were due last week. We also expect to have RFP's out next month for the first procurements of microwave landing systems and Mode S ground stations.

We also have a related study underway known as the National Airspace Review (NAR). The purpose of that review is to identify and implement

changes in airspace design and management, as well as in air traffic control procedures. Some of you probably are directly involved, or, at least your organizations are. So, whereas the National Airspace System Plan deals with facilities and equipment on the ground, the Airspace Review deals with all above the ground concerns. Here again, we are making good progress. In fact, at the last Executive Steering Committee meeting, we decided to compress the program schedule from 42 to 36 months. We want to make sure that this effort is completed by the end of 1984. Also, the Executive Committee already has passed on to the Administrator some 245 recommendations generated by the various task groups. The first group of 151 recommendations has been forwarded to the appropriate FAA offices for action and 8 of these have been implemented. Another 14 are scheduled for implementation later this year or early 1984.

Among actions already initiated is an agreement between FAA and the Canadian Air Transport Administration that identifies international notification procedures to be used by the two countries when there is a change that affects the operation of air traffic and airspace systems in the vicinity of the common border. Other NAR recommendations have been implemented, including 4 that pertain to charts used by pilots flying under visual flight rules (VFR). They involve eliminating excessive printing that causes what we call chart clutter and adding notification of hang glider areas and the like.

Individually, none of these actions could be termed revolutionary but, they are like threads in a fabric and I believe the finished product not only will promote safe and efficient flight, but also provide additional airspace capacity to accommodate expansion of the system.

Another area of critical concern is airport capacity. It could prove to be a significant constraining factor on future growth trends. And, unfortunately, it is not a problem that lends itself to quick and easy solutions. We are working this problem in the same systematic way we developed the Airspace System Plan and are currently proceeding with the National Airspace Review. One of our first priorities was to secure passage of the Airport/Airway Improvement Act, which reestablished the Airport Aid Program through fiscal year 1987, at significantly higher funding levels than in the past. Consequently, state and local governments now have the financial resource assistance to proceed with an orderly expansion of their airport facilities.

We are also looking at various technological and procedural means for increasing airport capacity. I mentioned the microwave landing system earlier, that certainly is one way to increase runway utilization/airport capacity. In addition, we have enlisted the support of industry in this effort with very promising results. I am referring specifically to the industry task force that was headed by Don Riley of the Airport Operators' Council International. We received a task force report last fall and we currently have a management steering group working to translate its recommendations into a cost effective plan of action.

So, in summary, let me say I am not one who believes we should trust the future to chance and circumstance. We may not be able to discount those factors entirely but we certainly can do our level best to shape the future to our own requirements.

Essentially, that is what we have been doing for the past two years at the FAA. We have been planning a system to accommodate the traffic projections we will be discussing here today. In fact, we have proceeded beyond planning and have begun actual implementation. I think we can face the future with considerable confidence that the national airspace system in the coming years, in the 1990's and beyond, will be equal to the demands placed upon it by the air transportation industry. What are those demands? What are they forecast to be? Well, that is the subject, of course, that will carry us through the rest of the day. We are probably ready to get on with the conference, but Tom has asked me if I might field any questions you might have that are pertinent to some of the comments I have made. Be glad to do so!

MR. MESSIER: If anyone has comments or questions of a general nature, we will be happy to entertain them at this point. Obviously not on the forecasts themselves but on anything you might want to ask relative to FAA development and so on.

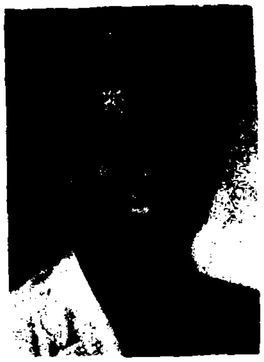
QUESTION: Will there be an update this year on the NAS plan? Will we have a new edition of the brown book?

MR. FENELLO: The answer to that is yes. As I mentioned, we have been updating and fine tuning as we begin to flesh out some of these ideas. Of course, the technology that is moving so fast has caused us to make some fine adjustments. Nothing spectacular but within two months, there will be a new edition, possibly within one month. It is pretty well completed now. As a matter of fact, we have progressed from a brown book to a red book now, which gets into some more R and D and some of the other stuff. And also, what we call our people book, because, as you can imagine we have a monumental task ahead of us to shift the skills of our personnel over into the new technology of new areas. Thank you very much and have a very fine conference.

MR. MESSIER: Thank you, Mike. I might also add that, in addition to the update this year of the NAS plan, the legislation that was passed last year does require us in fact to deliver a report to Congress, I think around either April 1 or the first part of April. We are well on

our way to doing that, and I think you will all find that informative when it comes out. It will summarize the various things that we have done the past year, where we stand, and what we see looking into the future and then followed shortly thereafter by the update of the NAS plan.

FAA FORECASTING INITIATIVE OVERVIEW



Thomas P. Messier
Deputy Director,
Office of Aviation Policy and Plans
Federal Aviation Administration

Good morning, ladies and gentlemen. Welcome to the FAA's Eighth Annual Aviation Forecast Conference. This conference is but one of many approaches FAA is using to set up a dialogue with you, the owners and users of the national airspace system.

The theme of this year's conference, "Aviation Forecasting: The State of the Art," shows our meeting will be of a more technical nature than those of recent years. It is our intent to have representatives from three sectors of the aviation community - Air Carrier, General Aviation and Helicopter - discuss the various techniques and mathematical models they employ in developing aviation forecasts. Since all forecasts are only as good as the economic assumptions utilized as model inputs, we have asked our luncheon speaker, Michael Evans, to present his views as to the future direction of U.S. economic activity.

Before I discuss the FAA's current forecasts, I would like to introduce the staff who have worked on its development:

- Mike Zywokarte - responsible for overall management direction
- Gene Mercer - overall forecast development and production
- Bob Bowles - air carrier forecast
- Arnie Schwartz - general aviation
- Chuck Moles - commuters
- Tom Henry - terminal area forecasts
- Virginia Price - statistical assistance
- Barbara Turner - text preparation.

You will recall that Mike Fenello just said that "No organization can plan effectively without having some kind of handle on the future." We like to believe FAA forecasts give us that handle. We use our aviation forecasts for a wide variety of policy, planning and budget functions within FAA. Aviation forecasting is one of the links that ties together planning for air traffic, air navigation and airports. The forecasts are also a key factor in policy work concerning aviation taxes and the assessment of benefits and costs of various systems as well as regulatory alternatives facing the agency.

Perhaps no single year so exemplifies the dynamic transition taking place within the industry as does fiscal 1982. To begin, the Air Traffic Controllers' strike resulted in restrictions being placed on both air carrier and general aviation flow into 22 high density airports. Second, the expected upturn in economic activity failed to materialize, leading to an outbreak of fare wars to stimulate depressed demand, with disastrous financial results for many air carriers. A combination of the depressed economy and high interest rates resulted in a twenty year low for shipments of general aviation aircraft. Fiscal 1982 also witnessed the failure of Braniff Airways as well as several smaller regional airlines. These failures sent shock waves throughout the aviation and financial communities.

The one bright spot for aviation in fiscal 1982 was declining fuel prices, although most, if not all, of the resultant savings were lost because of reduced fare levels. Declining fuel prices also had a negative impact on commercial aircraft orders, making the replacement of the current fleet less cost effective than originally anticipated.

To say the least, the last couple of years have been challenging to the aviation industry and to forecasters in particular. However, recent problems have not significantly altered aviation's long term trend. That trend is upward including expected growth in numbers of aircraft, expected growth in level of sophistication of aircraft and expected growth in aircraft operations.

Even with all our problems, 1982 data indicate that U.S. domestic certificated airlines accommodated over 207 billion domestic revenue passenger miles (RPMs) which is a two percent gain over the RPM record set in 1979. Another positive indicator is that available seat miles (ASMs) for fiscal year 1982 ran about one percent higher than in 1980 when a record of 349 billion ASMs were flown. What these figures tell me is that the public is strongly motivated to use air transportation for inter-city travel - even under difficult economic conditions and in the face of system capacity constraints. This makes me bullish over the prospects of long range growth. I am concerned, as are we all, about airline competitive pricing policies that have created a situation where last year the airline industry sustained an operating loss of $688 million dollars while flying a record number of RPMs.

In the four years since deregulation the character of the industry has markedly changed. Patterns of service, route structures and equipment usage have been altered in response to conditions in the market place and changes in operating costs. Since deregulation, some 65 carriers have been added to the list of certificated air carriers. Major mergers and acquisitions have occurred and several more are

likely. The certificated air carriers and commuters continue to ground or replace inefficient aircraft with more cost-effective aircraft.

The character of general aviation also continues to change. General aviation has become increasingly important as a means of transportation for business use. Businesses tend to concentrate their activities at those airports where aviation facilities are most extensive and where groundside services are most convenient. This means that we can anticipate even higher levels of demand at airports that are presently congested.

Cost and resource problems have become increasingly critical throughout the aviation community. Many commercial aircraft have reached the point where they will require replacement. The capital needs of the major airlines for the decade of the 80's are estimated at between 60 and 90 billion dollars. Acquiring this amount of capital will be one of the largest challenges the industry will face in the 1980's. We believe that by the mid-1980's, the airline industry will be entering a major equipment replacement cycle comparable to the replacement of piston engine aircraft with jet transports.

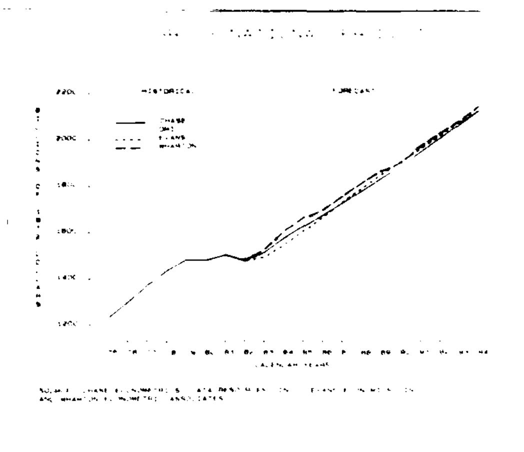
FAA Aviation Forecasts, 1983-1994

Let me now turn to our forecast techniques. The FAA forecasts are derived from econometric models which reflect the structure of the industry and the historical relationship between aviation activity and economic activity. These forecasts have proven to be accurate within one or two percent when evaluated over a five year time horizon. However, unexpected shocks or wild card events such as the oil embargo of 1973 and the air traffic capacity restrictions over the past year and a half can affect the short term accuracy of our forecasts. Therefore, our models, assumptions, and forecasts are continuously reviewed. If the forecasts are not following the trend of the actual values, adjustments are made.

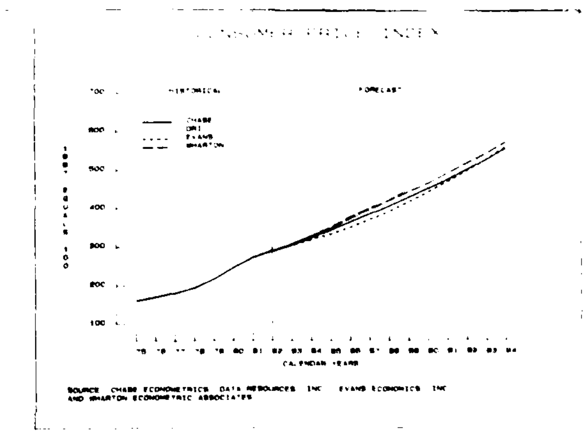
The principal economic drivers of the forecasts are gross national product, the consumer price index, and the oil and gas deflator. To a large extent the accuracy of our forecasts is dependent upon the accuracy of the forecasts of these variables.

Unlike previous years when FAA forecasts were founded upon only one set of economic assumptions, the current forecasts represent a consensus forecast which is based upon the average values of individual observations derived from projections prepared by four commercial forecasting services. We are using the following assumptions for the period 1982-1994.

The real gross national product growth estimates we used range from 1.2 to 3.2 percent in 1983 and averaged 3.1 percent throughout the forecast period.

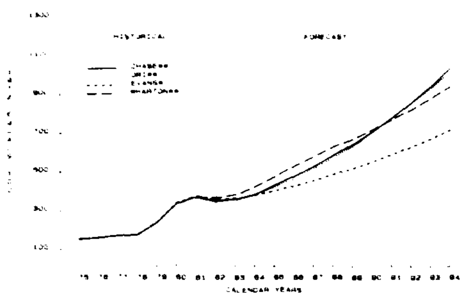


The consumer price index estimates are between 5.1 and 6.0 percent in 1983 and range between 5.6 and 6.5 percent for the entire forecast period.



Based upon the oil and gas deflator, fuel prices are forecast to increase between 2.4 and

4.2 percent in 1983 and grow at an average compound rate of between 6.0 and 9.4 percent between 1982 and 1994. In "real" terms, fuel prices are expected to range between 0.4 and 3.8 percent annually over the next 12 years. As you can see, the forecasts of fuel prices are not tightly grouped. Fuel prices and long term supply forecasts have been and will continue to be a challenge to all forecasters.



This chart shows the average annual growth rates for these three key variables as forecast by the four commercial economic services.

KEY ECONOMIC ASSUMPTIONS

VARIABLE	ANNUAL GROWTH RATE 1982-1994 (%) CHASE	DRI	EVANS	WHARTON
• REAL GROSS NATIONAL PRODUCT	3.1	3.1	3.1	3.1
• CONSUMER PRICE INDEX	5.6	6.5	5.6	5.8
• OIL AND GAS DEFLATOR	9.4	9.3	6.0	8.1

Beyond these general economic assumptions, we have made a series of assumptions specific to aviation:

1. Both general aviation and air carrier fuel prices will increase at an average annual rate of 8.4 percent.

2. The average passenger trip length of certificated air carriers is expected to grow by 3 miles per year.

3. The average seating capacity of commercial air carriers is expected to increase between 3 and 4 seats per year.

4. The revenue received per passenger mile for domestic operations is forecast to increase 6.4 percent annually in current dollars and 0.8 percent in 1967 dollars.

5. Domestic air carrier load factors are expected to increase from an average 58.4 percent in 1982 to 63 percent in 1988 and beyond for an annual growth rate of 0.4 points per year.

AVIATION SPECIFIC ASSUMPTIONS

VARIABLE	ANNUAL GROWTH RATE 1982-1994
• GENERAL AVIATION AND AIR CARRIER FUEL COSTS	+8.4%
• AVERAGE AIR CARRIER PASSENGER TRIP LENGTH	+3 MILES
• AVERAGE SEATS PER AIRCRAFT	+3-4 SEATS
• AVERAGE REVENUE PER PASSENGER MILE	+6.4%
• AVERAGE DOMESTIC LOAD FACTOR	+0.4 POINTS

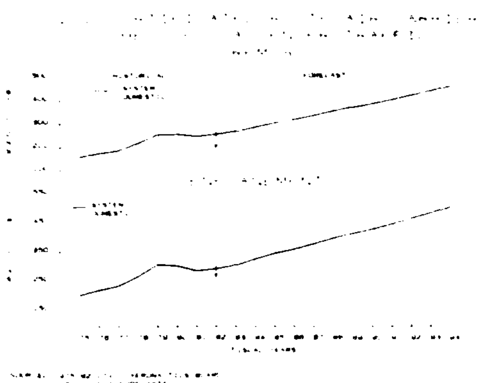
If these forecasts of economic activity are realized, and the relationship between economic activity and aviation holds over the long-term, we can expect continued growth in aviation activity. However, as we all know, for the past few years, economic forecasts have not always been on target. Because of this uncertainty it is important to bracket our forecasts by considering alternative scenarios based upon different sets of assumptions. Thus, we have continued our past practice of developing sets of long-term forecasts based upon alternative future scenarios.

AVIATION ACTIVITY FORECAST

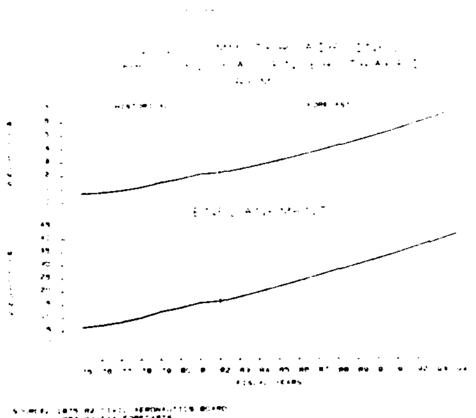
	1982	1994	ANNUAL GROWTH RATE (%)
AIR CARRIER DOMESTIC			
REVENUE PASSENGER ENPLANEMENTS (M)	272.6	471.1	4.7
REVENUE PASSENGER MILES (B)	207.5	375.9	5.1
COMMUTER CARRIERS			
REVENUE PASSENGER ENPLANEMENTS (M)	15.8	41.5	8.4
REVENUE PASSENGER MILES (B)	2.1	6.9	10.2
GENERAL AVIATION			
FLEET (000)	213.2	316.2	3.3
HOURS FLOWN (M)	42.6	66.3	3.8

Now to the forecasts themselves. Domestic air carrier revenue passenger miles are expected to

grow 4.8 percent in 1983. Through 1994, concurrent with recovery from the current recession, we expect domestic revenue passenger miles to grow by an average 5.1 percent per year, while revenue passenger enplanements are xpected to average 4.7 percent per year.



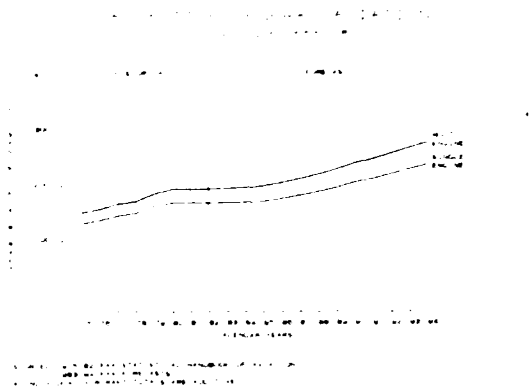
Commuter carriers are expected to sustain a higher average annual growth rate, particularly as new equipment enters the fleet over the next few years and the level of service resumes historical growth. Revenue passenger miles are forecast to average 10.1 percent annually over the entire forecast period, revenue enplanements 8.4 percent.

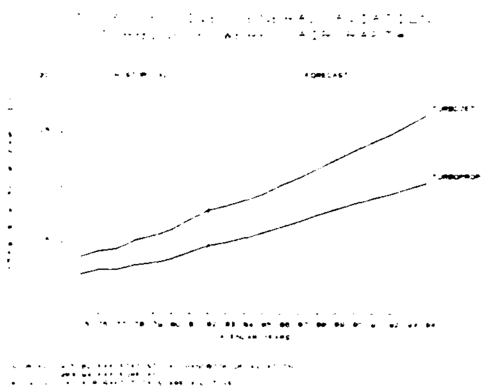


The general aviation industry will experience a continuation of slow growth in the GA fleet in the 1983-1985 period. However, we expect the yearly growth rate for the period 1986 through 1994 to be in the 4 percent range.

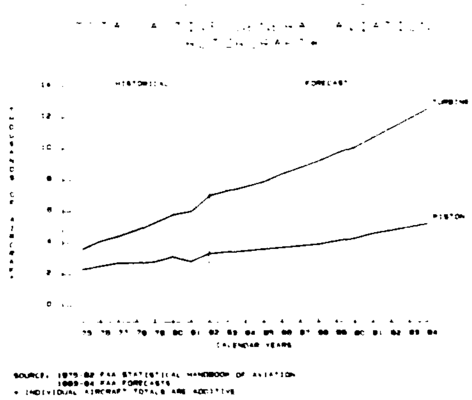
Active single-engine and multi-engine piston aircraft are forecast to grow at the modest rate of approximately 3 percent per year.

The number of turboprop and turbojet aircraft is expected to show significant growth during the forecast period. The number of turbine powered aircraft is forecast to more than double from 7,900 in 1982 to 16,600 in 1994.





The rotorcraft fleet is also expected to show significant growth, increasing at the rate of 5 percent per year.



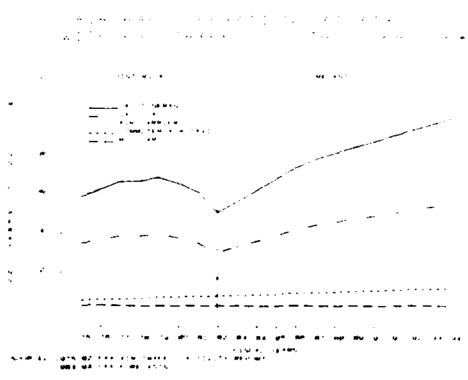
The shift in the general aviation fleet to more sophisticated aircraft will have a large impact in the demand for FAA provided services.

This chart reflects a summary of aviation activity growth that we are projecting from 1982 through 1994.

FAA WORKLOAD FORECAST

	1982	1994	ANNUAL GROWTH RATE (%)
TOTAL TOWER OPERATIONS (M)	50.6	99.7	5.8
INSTRUMENT OPERATIONS (M)	31.6	53.8	4.5
IFR AIRCRAFT HANDLED (M)	27.8	41.6	3.4
FLIGHT SERVICES (M)	62.4	96.0	3.7

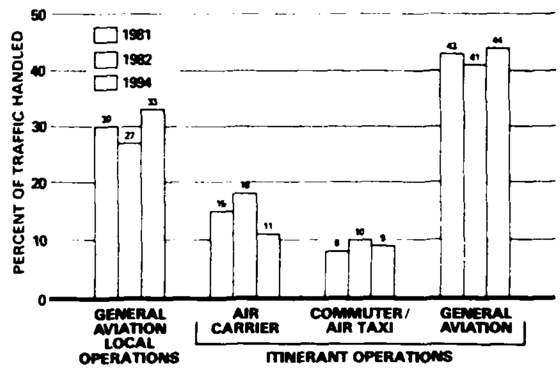
Total tower operations are forecast to increase by 11.5 percent in 1983 and almost double between 1982 and 1994. However, this expected increase is only part of the story. We expect to see a resumption of the trend, momentarily halted in 1982 due to the Air Traffic Controller's strike, toward increased participation in the system of commuters (including air taxis) and general aviation itinerant flying. Thus air carrier operations are expected to increase by only 24 percent over the time period while commuters and general aviation itinerant operations are expected to grow by 78 percent and 113 percent, respectively. General aviation local operations are forecast to grow by 142 percent.



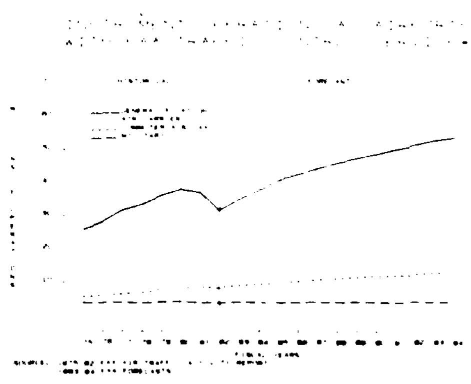
The net effect of these differential growth rates is a redistribution in the mix of operations in the system. Prior to the air traffic controller's job action, general aviation local operations accounted for 30 percent and itinerant operations 43 percent of total tower operations. By 1994 this will grow to 33 and 44 percent, respectively. Commuter/air taxi operations will increase from a total of 8 to a total of 9 percent between 1981 and 1994.

Air carrier operations are expected to decline from a total of 15 percent in 1981 to a total of 11 percent in 1994. This shift has implications for the operation of the air traffic control system since the more heterogeneous the mix of traffic, the greater the problems associated with control management.

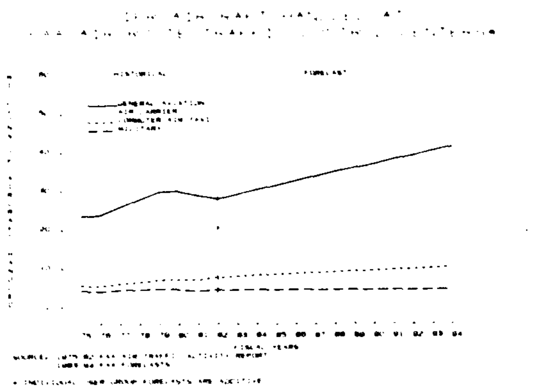
DISTRIBUTION OF OPERATIONS AT AIRPORTS WITH FAA TRAFFIC CONTROL SERVICE



Instrument operations at towered airports were not as impacted as total operations by the strike and are expected to increase at a slightly slower rate than total operations. Albeit the slower growth rate, the forecasts represent a continuation of the trend toward more sophisticated equipage of general aviation aircraft and their increased use for business and commercial purposes.

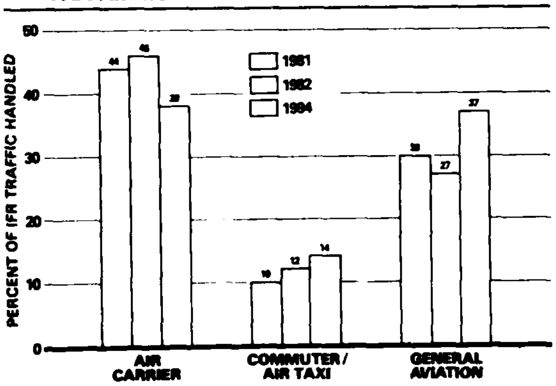


This trend is also reflected in the number of IFR aircraft handled by FAA Air Route Traffic Control Centers. While total activity is expected to increase by 50 percent over the next 12 years, air carrier aircraft handled are expected to increase by only 24 percent. Commuter and general aviation aircraft handled are expected to increase by 76 percent and 105 percent respectively.



Once again, these differential growth rates will result in a redistribution of the relative share of the workload. By 1994, the centers will be handling almost as many general aviation aircraft as air carrier aircraft.

DISTRIBUTION OF IFR TRAFFIC HANDLED BY FAA AIR ROUTE TRAFFIC CONTROL CENTERS



In summary, the data which we have presented show that the demand on the aviation system will continue to grow despite the setbacks of the last two or three years. The demand for FAA services is reflected in the forecasts of the FAA workload measures: tower operations, instrument operations at FAA facilities, IFR aircraft handled, and flight services rendered. These workload measures are all forecast to increase faster than the national economy. You will recall, we projected the GNP growth at an annual average rate of 3.1 percent.

If you look at the alternative forecasts carefully, you will observe that the general trend of the consensus forecast is closer to the "stagflation" scenario, reflecting the impact of the current economic downturn. However, the general trend for both the consensus forecast and the "economic expansion" scenario is upward, albeit at differing rates.

FORECASTS OF FAA WORKLOAD MEASURES-CONSENSUS AND ALTERNATIVE SCENARIOS

		FY 1994 FORECAST		
FAA WORKLOAD (MILLIONS)	FY 1982 BASE	ECONOMIC EXPANSION	CONSENSUS FORECAST	STAG-FLATION
TOTAL TOWER OPERATIONS	50.6	127.7	99.7	57.3
TOTAL INSTRUMENT OPERATIONS	31.6	85.9	53.8	44.9
IFR AIRCRAFT HANDLED	27.8	64.2	41.6	34.8
FLIGHT SERVICES	62.4	135.8	96.0	76.8

As I have already said, we anticipate that the same trends and changes evident within the aviation sector today will continue in the years ahead. Commercial aviation will continue to be affected by the deregulation process for several more years as carriers continue to rationalize their route systems and experiment with innovative ways of developing markets. Strong steady growth in the demand for commercial aviation is predicted throughout the 80's. However, we expect the major carriers' share of this increased demand to continue to decline as newly established low fare airlines, taking advantage of the depressed used aircraft market to buy aircraft at favorable prices, enter selective high density markets.

Commuter traffic and activity should continue to grow at a faster rate than the other segments of the aviation industry, although growth achieved through replacement of air carrier service should cease to be a major factor by the mid-80's. After that time, growth is expected to come from increased demand placed on a more stable and mature commuter airline industry.

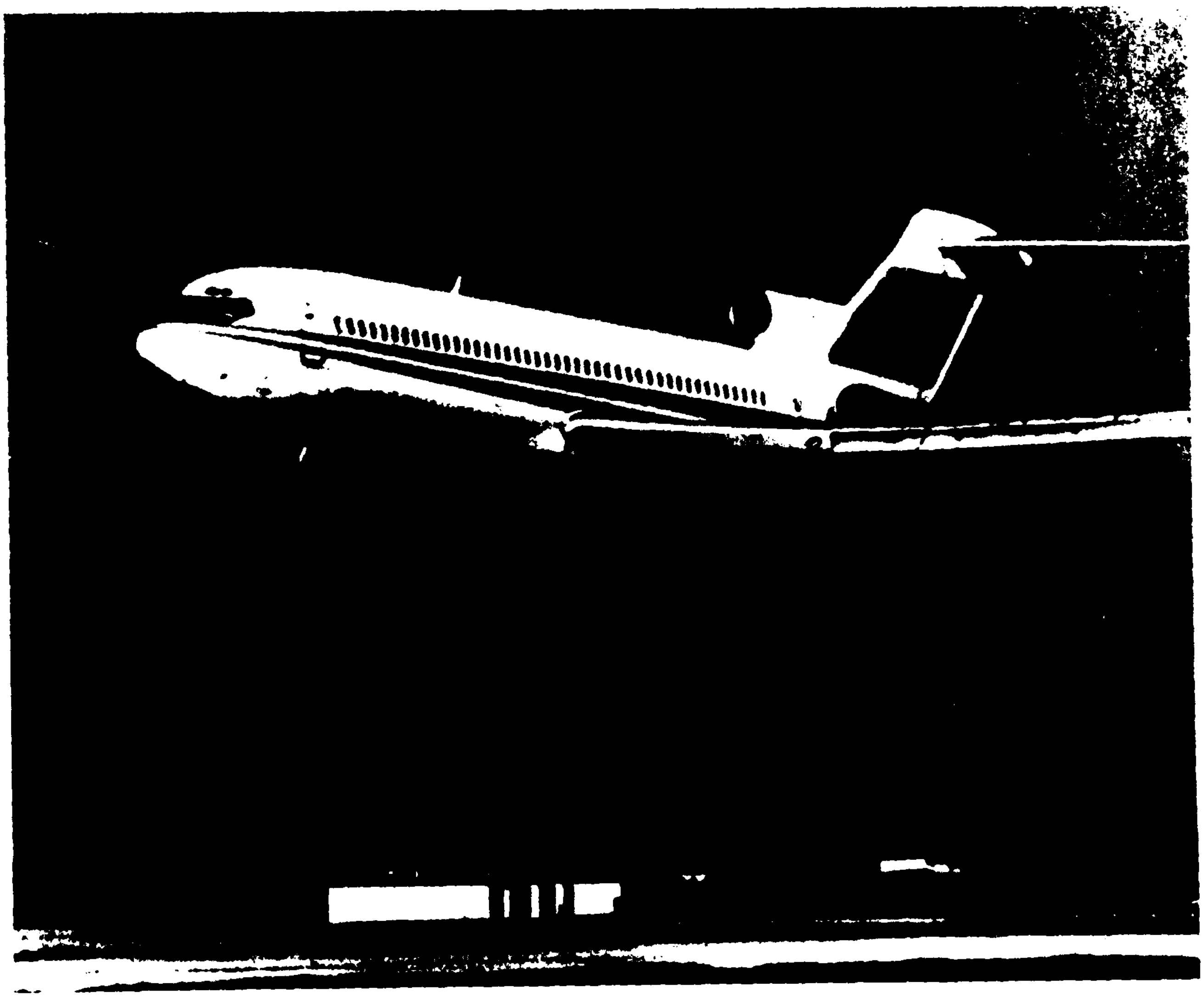
Also in the immediate future, we can expect further increases in the use of civilian helicopters, particularly in the formation of new helicopter airlines and in the off-shore oil industry as the search for oil extends farther and farther from the coastline. General aviation will continue to be important as a means of transportation for business use. Through the 1980's and 1990's we can expect significant growth in the turboprop and turbojet aircraft fleet and in the number of active

aircraft equipped with sophisticated avionics. These aircraft are usually intensive users of the national aviation system so we expect, during the latter part of the century, significant growth in the demand for FAA services from general aviation.

Overall we do not foresee any technological, social, or economic changes over the next 12 years which will be strong enough, in and of themselves, to reverse the long-term trends we are forecasting.

There may be cyclical perturbations about this trend, such as the recessions of 1975 and 1980-82, and the Air Traffic Controller's strike in 1981, but so long as we continue to provide an adequate infrastructure for the air transportation system, the long-term trend for all types of aviation activity is upward.

PANEL I
AIR CARRIER FORECAST MODELS



INTRODUCTION

MR. BOWLES: My name is Robert Bowles and I am responsible for the Air Carrier Forecasts that were discussed in the previous session.

The theme of this panel is Air Carrier Forecast Models. As the theme implies it is our intent to discuss the various techniques, models and data employed in developing aviation forecasts and not the forecasts themselves. However, if we have time during the discussion period, I am sure that the panelists will answer questions concerning their latest outlook for aviation. I also will be available to answer any questions that you have on the current FAA air carrier forecasts. I would also appreciate it if you would hold any questions you have until all three panelists have had time to make their presentations.

Our first panelist this morning will be Dr. Paul Biederman, whose presentation is entitled "Forecasting Passenger Demand at TWA." Dr. Biederman is currently the Manager of Forecasting at Trans World Airlines. He joined the staff in 1970 and has been in his present position since 1976. Prior to joining TWA, he held the position of Economist at both IBM and the Conference Board. Dr. Biederman recently received his Ph.D. in Economics from the New School for Social Research in New York City and holds a B.A. degree from Rutgers University. Dr. Biederman is also the author of a recently published book entitled The U.S. Airline Industry - The End of an Era. I hope that the title does not mean what it infers, but we will see. Dr. Biederman.

FORECASTING PASSENGER DEMAND AT TWA

Paul S. Biederman
Manager, Forecasting
Trans World Airlines

SUMMARY

Dr. Biederman of Trans World Airlines presents a practical approach to the science of forecasting. TWA favors the top-down or macro model over the bottom-up or markets approach. Use of the former model allows an almost instantaneous audit of predictive accuracy as the Airline Transport Association usually releases monthly industry-wide traffic volume totals just ten days after the fact. Thus TWA can evaluate management decisions based on forecasting and make adjustments where necessary. This is especially useful for determining opportunities for market entry.

INTRODUCTION

At the outset, I don't think it is an exaggeration to say that traffic and revenue forecasting is more difficult now than during regulation. Indeed, it is now more of an art than a science. By that I mean that the functional relationships which existed between the key variables in the sixties and most of the seventies and which are used to predict future behavior no longer accurately describe the recent past or the volatile present. This is because of the unique character of the pricing environment since mid-1979, and an unprecedented economic situation that has alternated between stagnation and recession for a prolonged period. For instance, our multiple regression model would have predicted an industry traffic change of minus fifteen percent (15%) in 1980, minus nine percent (9%) in 1981 and plus eight percent (8%) in 1982 had the actual independent variables been known at the time. The actual industry traffic changes were minus six percent (6%), minus seven percent (7%) and plus four percent (4%) for the three years respectively.

Although we produce long-term forecasts, largely for equipment planning, using the same methodology, our emphasis is short-term and we generate quarterly updates of our annual forecasts which are first produced during the summer of the preceding year. Our domestic and transatlantic (international) divisions are projected separately.

We use a top-down or macro approach as opposed to a markets or bottom-up approach. Why have we opted for this? TWA operates in over 400 domestic markets and we were able, with the help of Chase Econometrics during 1981, to forecast accurately (±5% error) an industry origin-destination market volume in nearly sixty percent (60%) of our 80 largest markets for the four quarters of 1980. Nevertheless, we decided to rely on the top-down approach primarily because we can nearly immediately monitor its accuracy (or lack thereof), establish causality for the variances, and embark on corrective actions where possible. Even if we were highly accurate with the market approach, we would not be able to differentiate market strength or weakness from TWA share performance because of the 6 to 9 month time lag in receiving the actual data from the origin-destination or service segment reports generated by the Civil Aeronautics Board (CAB).

Regional and markets forecasting models have been in vogue since deregulation as a means of determining new entry opportunities. With the top-down approach employed by TWA, we were able to assess causality for the forecast error very quickly (about ten days after the end of the month). However, we were not as fortunate in our transatlantic analysis because data from the IATA and the Immigration and Naturalization Service generally appear two months after the fact.

METHODOLOGY

We begin with an annual industry traffic forecast (old trunks and locals for domestic and transatlantic for our international division) in which multiple regression and auto-regressive models are used. The former incorporates real personal consumption expenditures, real total government (less national defense) spending, and real industry yield as explanatory variables in the domestic model, real U.S. gross national product, and real TWA prices (as an industry proxy) for the transatlantic (Figure 1). Over the years, we have also experimented with business/pleasure models domestically, and U.S. and European originating models internationally.

The trend, or auto-regressive model, incorporates the latest monthly industry traffic data. After adjustments for strikes, ATC problems, holidays, unusual price activity, etc., we use the model to project over the next 12-18 months.

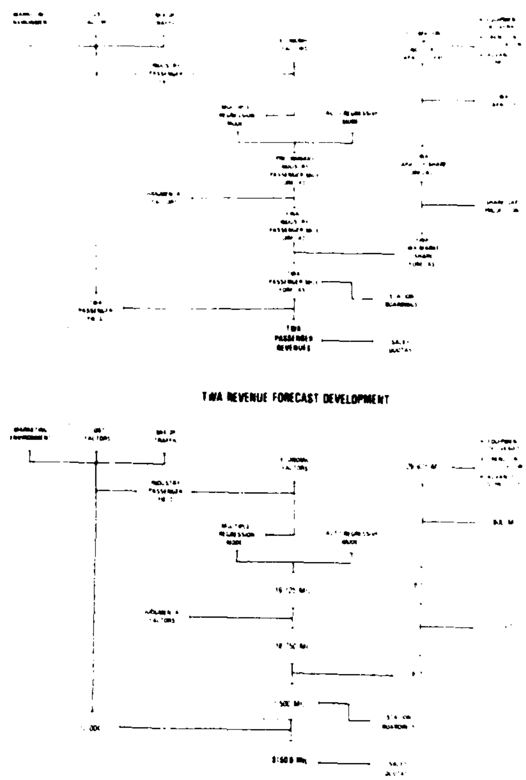
A vital input to the multiple regression model, is price. Here, after consulting our pricing people as to the competitive marketing environment, cost factors, and trends in traffic mix by fare type, we estimate the real price for the forecast period. Macro-economic inputs come from our own view of the economic outlook but

generally conform to the consensus. After obtaining the mechanical output of the models, we analyze the results for reasonableness. Here we are essentially dealing with confidence in the model and qualitative exogenous factors. Also we must convert the domestic trunks and locals total to the new majors' definition. With regard to confidence in the model, I can think of our 1980 experience as a useful illustration. After the big jump in oil prices and the subsequent unnaturally large increase in the average airline ticket price, our domestic multiple regression model was calling for a double-digit decline in industry traffic. Because we chose not to believe the regression coefficient of real yield (over -1.0), we accorded -.5 to the expected real yield in 1980 and, by sheer luck, correctly forecast the 6 percent traffic decline. Bear in mind that this was the first calendar year decrease of the post-war period and even this small decline was difficult to sell to management. Nevertheless, because we did convince management of the impending traffic fall, TWA did shrink its operation ahead of the industry in general and was able to report relatively favorable operating results for 1980 and 1981. Qualitative exogenous factors come into play when, for example, your boss decides subjectively that the forecast is either too high or too low. For 1983, after all was said and done, we initially predicted 4-5 percent traffic growth with a nominal yield increase of 5 percent. Now, however, with the fourth and first quarter price wars, we think that traffic growth should reach about 8-9 percent, while industry yield may be up by only 0-1 percent. The bottom line is that we think aggregate industry revenue will probably come out roughly in the same place, or about 8-9 percent over 1982.

Once our industry forecast is solidified, we move to estimate TWA's traffic share by projecting a share of industry capacity and determining our "share gap." In forecasting industry capacity we rely on equipment delivery/retirement schedules, trends in utilization, and advance schedules. With TWA's capacity given, we thus derive a share and must then estimate the "share gap." The "share gap" represents the difference between the capacity and traffic shares. If the traffic share exceeds the capacity percentage, the "share gap" is said to be positive (which happens to have been TWA's position since 1979). The "share gap" for the forecast period is generally figured on how you expect to perform competitively compared to the base year, but lately has been more a function of the number of price wars involving you relative to the industry at large. Deciding this "share gap" enables us to determine the traffic share, hence TWA traffic. From the left side, we then apply a TWA yield projection, which is an outgrowth of our industry yield forecast estimated earlier as a regression input, and

Figure 1

TWA REVENUE FORECAST DEVELOPMENT



obtain TWA revenue. The annual figures are broken down into quarters and months according to seasonal relationships. In addition, the TWA traffic forecast is the basis for a projection of individual station boardings which help us adjust personnel levels around the system. Final aggregate revenue is broken down by station in the form of sales quotas which become station performance measures.

MONITORING

As mentioned earlier, the major factor in our choice of the top-down forecasting procedure had to do with being able to determine quickly the variances of the forecast. Thus within ten days or so, at least domestically, as the industry traffic and capacity volumes become available through the Air Transport Association, we are able to isolate the reasons for the errors. Figure 3 illustrates a hypothetical revenue variance analysis. Here we divide causality into three parts:

1. Industry size
2. TWA traffic share
3. TWA price

From Figure 2, we saw that forecast or plan revenue was $150 million but actually came in at $145 million for a shortfall of $5 million. Industry growth was 1.3 percentage points stronger than anticipated adding $2 million, but our traffic share of 7.8 percent was .2 percentage points worse than expected which cost us $4 million. Upon closer inspection of the components of the traffic share, we can see that our capacity share at 8.6 percent was .1 percentage point higher, which helped revenue rise. But our "share gap" was .3 percentage points under plan which reduced revenue by $6.5 million. Moreover, our yield was 2 percent under plan costing us an additional $3 million.

Essentially then, our revenue shortfall resulted from a weak "share gap" and lower prices. While the price problem at least for the present is not something we can control, we definitely can do something about the "share gap" miss. When this happens, we take pains to isolate problem markets and try to identify any competitive disadvantage with regard to scheduling, product service, or price. Once located, we can take actions to redress performance deficiencies wherever they occur.

In summary, while the choice of forecasting methodology is obviously important, at TWA the forecast is not an end itself but rather a working management tool for assessing our performance within the industry.

Figure 2

REVENUE VARIANCE ANALYSIS
ACTUAL VS. PLAN
(MILLIONS OF DOLLARS)

PLAN REVENUE	$150.0		
VARIANCES DUE TO			
1. INDUSTRY GROWTH [illegible]	2.0		
2. TWA SHARE			
INDUSTRY RPMs [illegible]	(4.0)		
INDUSTRY ASMs [illegible]		2.5	
TWA [illegible]			[illegible]
[illegible]			[illegible]
SHARE GAP [illegible]		[illegible]	
3. TWA YIELD [illegible]	[illegible]		
NET	$ (5.0)		
ACTUAL REVENUE	$145.0		

MR. BOWLES: Our next panelist is William Dickens, whose presentation is entitled "Fleet Planning - A Macro-Analytical Approach." Mr. Dickens is currently Supervisor of Commercial Market Research in the Group Strategic Planning Department of Pratt & Whitney Aircraft. In this position he directs all group forecasting activities associated with civil aircraft engine markets encompassing both the airline industry and general aviation. His responsibilities include the development of long range traffic and sales forecasts, identification of product requirements, competitive analysis and the formulation of long range business strategies. He joined Pratt & Whitney in 1966 and has been in his present position since 1972. Between 1957 and 1966, he was a research Physicist at Johns Hopkins University's Applied Physics Laboratory. He received both his B.S. and M.S. degrees from the University of North Carolina, home of Dean Smith and the 1982 NCAA Basketball Champions. Mr. Dickens also holds a J.D. degree from the University of Connecticut School of Law.

AIRLINE FLEET PLANNING A MACRO ANALYTICAL APPROACH

William P. Dickens
Supervisor, Commerical Market Research
Pratt & Whitney Aircraft

SUMMARY

Mr. Dickens presents the planning model developed for use by Pratt & Whitney to assess future airline aircraft requirements. He describes the three data banks used as resources with special emphasis on interaction with the Airline Traffic and Capacity Forecasts, and the various levels of detail accessible to the system user.

INTRODUCTION

Bob said that about Dean Smith because we both have the same "alma mater." I thank him for his great introduction, except I don't know if it really helped me any. It is very obvious, I'm sure, to all you forecasters out there that based on the history he just gave you, I really didn't forecast my career, I sort of fell into it.

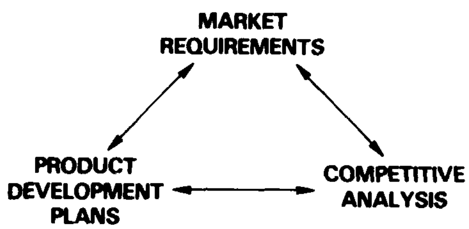
Before you give me a black mark for it, I think it is obvious today that probably the most important trait any forecaster can have is the ability to fall into it. Especially if he does it with any consistency. I do have other qualifications for forecasting. I had a bad year last year but I did pick the Washington Redskins to win the Super Bowl. I also picked them to win for the last nineteen years in a row. So, forecast frequently. I have six kids ranging in age 2 to 26 and I forecast the sex of every single one of them. It doesn't say much for my planning ability.

I am speaking on forecasting this morning so we can ignore my planning qualifications. I am not going to be showing you any forecasts unless pushed. What I am going to be talking about is one of the particular forecasting tools that we are using at Pratt & Whitney.

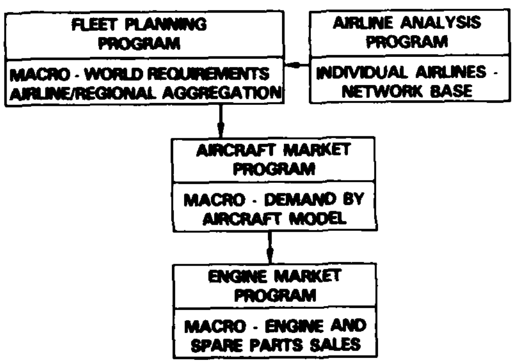
All segments of the air transport industry are involved to varying degrees in fleet planning. However, forecasting requirements and the nature of the planning process varies considerably

among manufacturers, airlines, regulatory agencies and financial institutions. As a result, a broad spectrum of planning tools and techniques has been developed. As an aircraft engine manufacturer, our fleet planning requirements encompass all of these various perspectives to some degree. The methodologies we employ are diverse, ranging from the microscopic complexities of airline route assignment and aircraft allocation models to large macroscopic models used to forecast world airline traffic demand.

PRIMARY OBJECT OF PLANNING MODELS LONG-TERM AIRCRAFT/ENGINE MARKET EVALUATIONS



COMMERCIAL MARKET RESEARCH PROGRAMS PRODUCT PLANNING FUNCTION



The macro approach to fleet planning that will be described was specifically designed for the purpose of reconciling macroscopic aircraft demand analyses with aircraft delivery projections at the individual airline levels or at other sublevels in the demand hierarchy. The resultant program has proven to be an effective interface between these different levels of analysis. The program has provided a means of rationalizing overall industry projections at the airline level through the creation of plausible aircraft delivery schedules.

Because of its design, this program would appear to have considerable utility beyond the special purpose for which it was developed. While all possible applications will not be specifically detailed, many will become apparent in the description of the methodology and operational characteristics of the program.

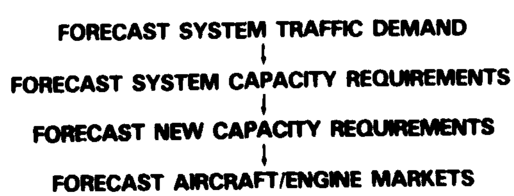
Fleet Planning Model — General Description

The fleet planning model employs macro techniques to evaluate and aggregate the future aircraft requirements of up to 200 individual airlines. Although the program independently makes annual equipment replacement and purchase decisions, a total "hands on" capability is provided that retains the facility for general parametric analyses. The program employs relatively simple mathematical calculations and algorithms. The program does not incorporate route analysis techniques, aircraft scheduling methodologies or a fleet optimization capability.

The basic process employed by the fleet planning model can be briefly summarized. Traffic and capacity forecasts are calculated for each airline and a resultant capacity gap is created using various replacement techniques. This gap is filled on an annual basis by deliveries of individual aircraft models. Various output routines permit a detailed evaluation of replacement and delivery transactions, traffic and capacity levels, and other descriptive parameters. Data may be summarized for an individual airline, for the total system, by region, or airline grouping. The program has the capability of operating over a forecast period of up to 15 years.

A key attribute of the program is the nature and utility of the numerous "control levers' available to the user. The interactive mode provides the operator the capability of controlling the program outputs. Operational controls are available at the system level, the regional level, and at the individual airline level. This capability facilitates parametric modifications and adjustments. Changes in market or fleet operational assumptions can be made easily, quickly, and economically.

MACROSCOPIC FLEET PLANNING PROCESS TRAFFIC DEMAND TO AIRCRAFT/ENGINE MARKETS



in this file will be outlined separately.

MACRO APPROACH SATISFIES PRIMARY REQUIREMENTS
DATA INTENSIVE BUT WITHOUT UNPRODUCTIVE COMPLEXITIES

SYSTEM DOES	SYSTEM DOES NOT
• CONSIDER INDIVIDUAL AIRLINES	• INCORPORATE ROUTE ANALYSIS CAPABILITY
• PROVIDE AGGREGATE REQUIREMENTS ANALYSIS	• INCORPORATE AIRCRAFT SCHEDULING ALGORITHMS
• PERMIT GENERAL PARAMETRIC ANALYSIS	• INCORPORATE FLEET OPTIMIZATION TECHNIQUES
• INDEPENDENTLY MAKE EQUIPMENT DECISIONS	• INCORPORATE COMPLEX PARAMETRIC ALGORITHMS
• PROVIDE HANDS-ON CAPABILITY	• OPERATE WITHOUT KEY USER INPUTS

Input Requirements

Although the fleet planning model operates in conjunction with a large input data base, operator input requirements are minimal after the initial control data file has been created and the system calibrated. With the exception of overrule data which may be utilized at the analyst's discretion, user inputs are confined primarily to operational control parameters. The major body of the input data file is created through direct on-line access of three large data banks that are created and maintained external to the fleet planning model. These data banks are used for numerous other market research activities.

The Aircraft Inventory Data Bank is an interactive system providing access to more than 10,000 aircraft records. Complete historical data on all jet aircraft delivered to the world's airlines is stored in this file. This data includes operator identification, purchase, retirement, and transfer information, and aircraft and engine manufacturer designations. The information in this data bank is updated quarterly.

The Descriptor Data Base provides detailed master lists of engines and aircraft with key descriptors and attributes for each model entry. This is also the central file for master lists of airlines, countries, regions, and manufacturers. Also residing in this data base are the constants and time scale parameters utilized by the Airline Traffic and Capacity Forecasting Program, as well as average aircraft productivity data stored by aircraft model. This data base is a key file in the operation of several other market research models.

The fleet planning model also has direct access to the data file created by the Airline Traffic and Capacity Forecasting Program. This file contains individual airline capacity forecasts as well as historical capacity data. Since this data file is central to the operation of the fleet planning model, the methodology employed to forecast the airline data contained in this file will be outlined separately.

The fleet planning model accesses these three external data sources and stores both the general and specific airline information in its own control data file. Specific airline data include the system capacity forecast and current fleet information, such as number of aircraft by model and the span of years over which these aircraft were delivered. General input data includes key vehicle and engine descriptors and average productivity factors for each aircraft model.

Additional input data are entered into the fleet planning model control file by the user. These input requirements include general fleet mix specifications, capacity overrule data, vehicle productivity scale factors and profiles, aircraft replacement factors, "menus" of available gap vehicles, and operational parameters for allocating gap vehicles. Some of these inputs are optional and are utilized only when data obtained from external data sources are overruled.

Airline Traffic and Capacity Forecast

Unless a specific capacity forecast is input for an airline, the fleet planning model will operate on data obtained from the external file created by the Airline Traffic and Capacity Forecasting Program. This program operates in conjunction with an historical data bank that presently contains traffic and capacity data for 125 individual airlines; all of the remaining world traffic is accounted for in regional groupings. At present, the historical data encompasses the period 1963-1982, providing a forecast capability of 15 years. The program develops individual airline traffic and capacity projections by means of a disaggregation technique that will be briefly summarized.

The key operational inputs to this program are aggregate traffic forecasts for the United States system and the overall non-United States system. Unless specific overrules are employed, all of the program computations will be keyed to these overall demand projections. In the non-overrule mode, individual airline forecasts are derived by developing forecast market shares for each airline based on a regression of historical data and applying these shares to the aggregate forecast. This procedure may be used against either an overall system forecast or separate regional forecasts.

The overrule mode incorporates several different techniques. An airline traffic forecast may be directly input either for the entire forecast period or for a portion of the forecast period. Another alternative is to specify a percent share for the last year over which the forecast is to be made. The regression program used to develop airline market shares will operate using historic and all specified future shares. Individual airline forecasts developed in the overrule mode may either be normalized relative to that of the

aggregate forecast, or excluded from this normalization procedure.

The capacity forecasts available for access by the fleet planning model are derived for each individual airline or group using these calculated traffic projections and an annual load factor that is either directly input by airline, or developed using regression techniques similar to those used in the traffic forecasting mode. These load factors are derived on an annual basis for each airline or airline grouping.

Although the fleet forecasting model has direct access to the capacity data developed by the Aircraft Traffic and Capacity Forecasting Program, it may also be operated using annual airline system capacity forecasts that are directly input into the control data file of the fleet planning model. All airlines not having a specified capacity forecast will operate relative to the projection obtained from the data file of the Airline Traffic and Capacity Forecasting Program. If the capacity forecast for any airline is overruled, the normalization constraint obviously is no longer in effect.

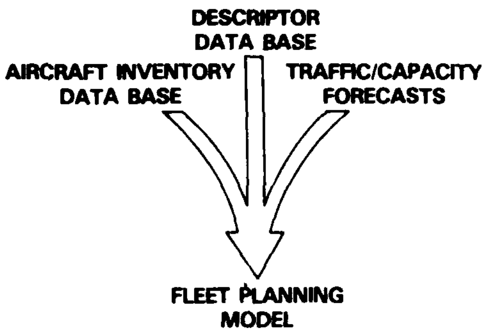
The overrule capability, coupled with disaggregation methodology, affords considerable flexibility for testing demand assumptions. By simply changing forecast capacity at the world level, individual airline projections of capacity and equipment requirements can be modified. Conversely, the effect of altering an individual airline forecast can be quickly monitored on a system-wide basis. This ability to change or test capacity growth assumptions also can be employed at any intermediate level. Individual airlines or regions can be excluded from the adjustment process by a simple overrule command.

Airline Capacity Disaggregation

Disaggregation techniques allocate an airline's future capacity requirements to various generic categories. For each airline or airline group, up to six aircraft range/size categories may be specified. The base-year percentage of available capacity in each category is determined from calculations utilizing inventory data accessed from the Aircraft Inventory Data Bank.

The share of total capacity allocated to each range/size grouping is controlled by the operator. The base-year split may be retained, the initial split may be increased or lowered by means of a selected growth profile, or the future split may be directly input for any or all of the selected range/size groupings. Various combinations of these options are available. It is also possible to restrict the disaggregation process solely to the incremental capacity generated through system growth, holding the base-year capacity distribution constant.

FLEET PLANNING MODEL
MAJOR COMPONENTS



INPUT DATA REQUIREMENTS
PRIMARILY COMPUTER ACCESSIBLE FROM
EXTERNAL SOURCES

PROJECTED CAPACITY
- AIRLINE FORECAST (BASE)
- AIRLINE FORECAST CONSTRAINED
- OVERRULED

BASE YEAR FLEET
- MODEL - AGE - TYPE - PRODUCTIVITY

RETIREMENT SCHEDULE
- SPECIFIC
- ALGORITHM

DELIVERY SCHEDULE
- SPECIFIC

COMPUTATIONAL PARAMETERS
- PRODUCTIVITY CHANGES
- RANGE/SEAT GROUPS (SHARES)

MACRO AIRLINE TRAFFIC MODEL VARIABLES
REVENUE PASSENGER MILE FORECASTS

UNITED STATES
- WAGES AND SALARIES
- PERSONAL CONSUMPTION EXPENDITURES
- PER CAPITA DURABLE AND NON-DURABLE CONSUMPTION
- YIELD
- TIME

NON-UNITED STATES
- GNP - MAJOR INDUSTRIAL COUNTRIES
- GNP - OIL PRODUCING COUNTRIES
- GNP - LESSER DEVELOPED COUNTRIES
- U.S. GNP LAGGED

The control options afforded by this approach readily permit adjustments to the characteristics of aircraft demand requirements. General or specific airline fleet mix assumptions can be easily imposed at any level and the results evaluated. These simple controls also facilitate the evaluations required in the reconciliation process.

AIRLINE AND REGIONAL TRAFFIC FORECASTS METHODOLOGY VARIES

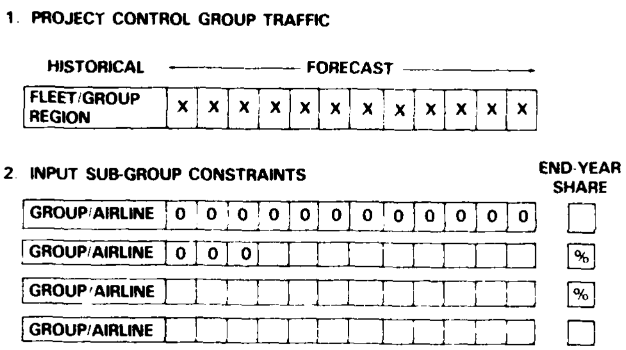
DISAGGREGATION

- REGRESSION OF HISTORICAL MARKET SHARES
- NORMALIZATION VS. BASE FORECAST

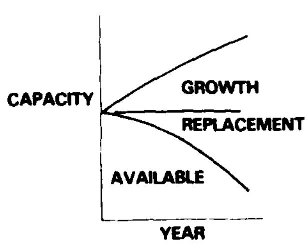
DIRECT FORECAST

- OVERRULE
- OVERRULE WITH NORMALIZATION

TRAFFIC FORECASTS DISAGGREGATION METHODOLOGY



CAPACITY GAP ANALYSIS GROWTH/REPLACEMENT COMPONENTS



- EACH RANGE/SEAT GROUP
- CURRENT DELIVERY SCHEDULES
- CURRENT REPLACEMENT PLANS
- REPLACEMENT ALGORITHM

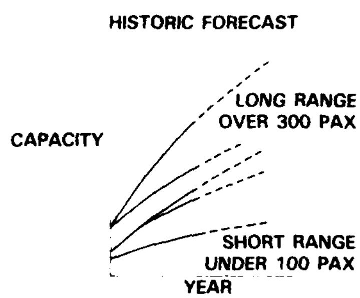
Fleet Replacement

The fleet replacement procedures used by the program are specified by input commands prior to operation. The replacement algorithm operates directly on the base-year fleet. Aircraft are removed from service by replacement profiles that are keyed to age, a specified operating life, and a specific replacement pattern relative to these factors. Actual aircraft delivery dates are not used in this process; instead a delivery distribution profile is established for each aircraft model prior to operation. The selected profile approximates the actual delivery pattern and is a function of delivery period, year of initial delivery, and overall number of aircraft delivered.

The capability to directly input a specified replacement schedule by airline for any aircraft model is also available. This may be a complete or partial overrule. In such cases, the input schedule is in control for the specified period after which the designated replacement algorithm is employed.

This methodology permits the user to make major adjustments in replacement assumptions quickly. Changes can be made at any level by simply changing the designated service life of any or all models, or by imposing a different replacement profile. The overrule capability permits additional fine tuning at the airline level.

CAPACITY REQUIREMENT COMPONENTS RANGE/SEAT GROUPINGS



- PERCENTAGE OF TOTAL CAPACITY
- EACH INDIVIDUAL AIRLINE
- HISTORICAL TRENDS
- INPUT OVERRULES

DEVELOPMENT OF CAPACITY GAP ANNUALLY FOR EACH RANGE/SEAT CLASS

C_T	TOTAL ASM REQUIRED
C_{RP}	PLANNED ASM REMOVED
C_{AP}	PLANNED ASM ADDED
C_{RS}	NET REMOVED ASM PER REPLACEMENT ALGORITHM
G_I	INITIAL CAPACITY GAP (ASM)
G_A	ADJUSTED CAPACITY GAP (ASM)

$$G_I = C_T - (C_{RP} + C_{RS}) + (C_{AP})$$

Capacity Gap and Aircraft Allocations

An initial capacity gap is developed for each airline and each range/size category specified for that airline. Each gap represents the additional capacity needed to satisfy the requirements of each category after available fleet capacity and any input "planned capacity additions" have been removed.

Aircraft productivities utilized to calculate capacity replaced and added are allocated by specific input commands that afford the user considerable flexibility. Each aircraft model for an individual airline may either generate capacity at the average level contained in the control file or at a level specified by a scaling factor that is applied to the average productivity. Productivities may be varied over the forecast period.

Aircraft are added to an airline fleet to satisfy these gap requirements. However, the program does not independently select aircraft models from a "menu" of available equipment. The specific aircraft model available for filling a gap in a given year must be identified prior to operation. Aircraft model selections are input into the control data file. The "availability period", year and month, is specified for each model by airline. Used aircraft may be designated to satisfy gap requirements. These aircraft are selected from a used aircraft pool created during the operational process.

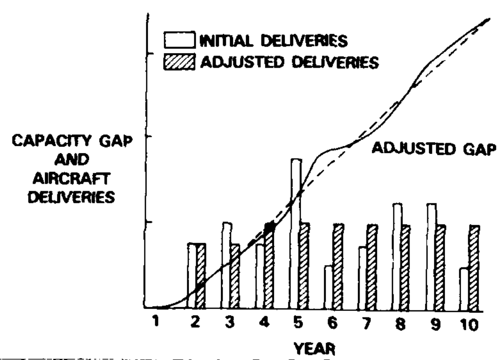
The program attempts to fill each capacity gap by adding aircraft in a reasonably spaced delivery pattern. This process is constrained by the gap requirements of the following year since this requirement cannot be exceeded by previous capacity additions. Input controls specify the amount of capacity that can be "borrowed" from the following year.

The resultant output of the fleet planning model is an annual summary of vehicle and capacity transactions by model by airline and in total for any other hierarchical level. Major refinements or adjustments can be made after examination of output data through simple modifications of input controls. The capability to modify specific delivery schedules is confined to the individual airline level of operations.

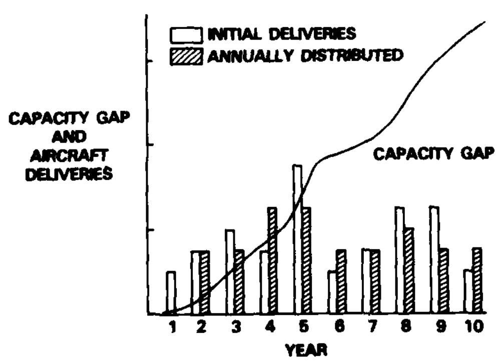
FLEET DEVELOPMENT SUMMARY AIRCRAFT ADDITIONS AND DELETIONS

RANGE/SEAT CATEGORY	AIRCRAFT MODEL	TRANSACTION YEAR 1983	1984	1985
1	1	X	X	
	2			
	3			X
	4			
2	1	X		
	2		X	X

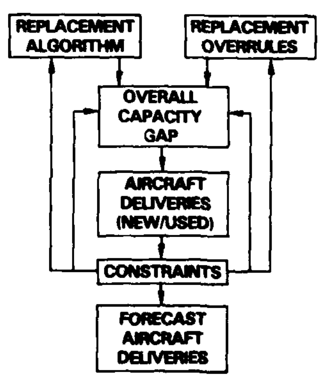
DELIVERY SCHEDULE ADJUSTMENTS GAP SMOOTHING THROUGH REPLACEMENT CONTROLS



DELIVERY SCHEDULE ADJUSTMENT ANNUAL DELIVERY PROFILES CAN BE ESTABLISHED



OUTPUT EVALUATION CRITICAL INTERACTIVE CAPABILITY REQUIRED



EVALUATION OF OPERATIONAL CONSTRAINTS
INTEGRATED OPERATION

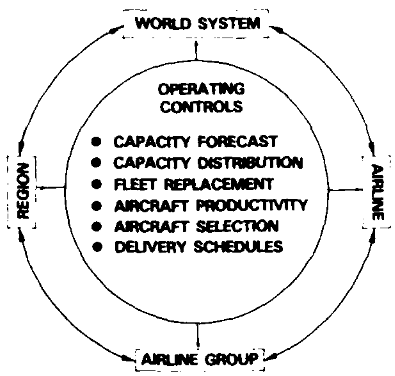
GENERAL ADJUSTMENTS AVAILABLE

- CAPACITY LEVELS
- OVERALL REPLACEMENT SCHEDULES

INPUT ADJUSTMENTS REQUIRED

- FREQUENCY
- CAPACITY BY AIRCRAFT TYPE
- DELIVERY SCHEDULES BY MODEL
- AVERAGE AIRCRAFT SIZE

OPERATING CONTROLS AVAILABLE AT ALL LEVELS
ANY ADJUSTMENT CAN MODIFY ALL LEVELS



SUMMARY

This fleet planning model was specifically developed as an integral part of our overall planning process. An effort was made to interface effectively with other programs and to achieve an interactive capability that would permit iterative application and evaluation of all of these methods.

The described methodology is not presented as an approach that is suitable for analysis of all of the varied fleet planning requirements within our industry. However, the technique has proven to be effective as an integral part of our planning process both as a forecasting tool and as a learning tool. The methodology, flexibility, and productivity of the system appear to be readily adaptable to a variety of applications.

MR. BOWLES: Thank you, Bill. Our next panelist is David Keith, who is currently Director of Data Base Services at I.P. Sharp Associates in Toronto. David received his Master's Degree from the University of Waterloo in 1969 and then joined I.P. Sharp as Manager of the Montreal branch office. His first exposure to aviation data occurred during a project with Air Canada which required use of Civil Aeronautics Board (CAB) Form 41 data. In 1975, he initiated a data base group for the company and concentrated primarily on building an extensive aviation data base and associated analytical tools. I.P. Sharp's most popular tool, "Magic," is now used to access data bases for over one hundred aviation related organizations in the world. David's topic this morning, "Aviation Data Availability," will cover the history and most likely future availability of U.S. aviation data.

AIRLINE DATA AVAILABILITY

David A. Keith
Director, Data Base Services
I.P. Sharp Associates

SUMMARY

Mr. Keith describes the availability of industry data. He gives particular emphasis to the changing role of the Civil Aeronautics Board.

INTRODUCTION

Thank you very much, Bob. I am not sure that everyone in the room knows who I.P. Sharp Associates is and I thought I would give a brief introduction to the company and the kinds of things that it does. If I could have the first overhead.

In a nutshell, we are a computer time sharing company with a network that allows people to dial in to a central computer system from about 500 cities in the world so that if you are sitting in Australia or Singapore, you can dial in and access data from a data base the same as people could in any other city. It is fairly quick and instantaneous type of a situation. We have offices around the world that assist people in doing these kinds of things.

Almost by accident, we got into the aviation business. When I was in Montreal, Air Canada asked me if I would help them analyze some Form 41 data which I had never heard of before. They were working with pencil and paper. They told me that there was a computer data base from the CAB, and maybe there would be an opportunity to go and get that data and put it on the system. We didn't even have any U.S. operations at the time, but what the heck, we ordered some tapes from the CAB and pretty soon had the tapes up on the system and a data base that was consistent across time. We suddenly found that Air Canada's Operations Research Department, which I had been working with, was disbanded and suddenly we had the data base and absolutely no customers.

Fortunately, we opened offices in the U.S. - our first was in Los Angeles. The fellow who manned that office had been at McDonnell-Douglas and went back to them and said "Here's the CAB data. Why don't you people look at it?" They did and found that, in fact, the work that they had been doing by hand could easily be done using the computer system. So they became basically the first user of data on a regular basis.

Soon after this, Lockheed joined the bandwagon and pretty soon we had a critical mass of users using the data so that we could proceed in improving the data base and doing the work in that direction.

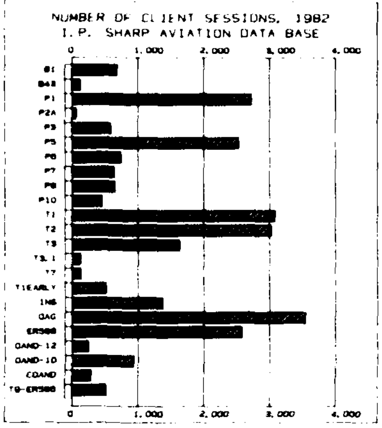
From that point on, we did a lot of expansion and wrote a lot of software. We now have about 120 customers or so for this data.

Things were proceeding along exceedingly well until about 1979 when the Airline Deregulation Act of 1978 was passed and suddenly there was doom and gloom about the future of the data in that the Act made no reference to the continuation of the data that had been collected by the CAB. The big question became "Will the data survive the sunset of the Civil Aeronautics Board?" If past activity is any indication of the future, then I think it is accurate to respond: "Yes, the data will survive, and the most useful parts of it will survive in roughly the same format as they exist today." This attitude reflects a rosier picture than the one we were faced with two years ago, and I believe we owe a great deal to the staff of the CAB for their perseverance and consistency of purpose in the preservation of this valuable national resource. There is no question that if they had wavered in their attempts to protect the data, serious damage would have occurred to the data collection procedures which may have taken years to repair.

Two paragraphs from a recent memorandum issued by the Office of the Comptroller, Civil Aeronautics Board, summarize the current situation. They follow:

> Preparations for sunsetting CAB information systems is being closely coordinated with other Federal agencies, including Transportation, Commerce and Air Force. DOT's coordinating representative was designated by their Assistant Secretary for Policy and International Affairs. DOT and other agencies are precluded by law from collecting data that CAB already collects. As a result, they have program uses for our information in addition to the CAB programs they will assume after sunset. We are attempting to accommodate the essential data needs of these other Federal agencies, and to the extent represented by these agencies, the needs of the private sector users.

> While we are cooperating with DOT on a program that assumes transfer of the systems to DOT at sunset, the Airline Deregulation Act of 1978 does not clearly mandate such transfer. Amendment of the Federal Aviation Act to

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TITLE  SYSTEM MAJORS   SCHEDULED SERVICES
LABEL  RPM, ASM, LOAD FACTOR, REVENUE, YIELD
FOOTNOTE  SOURCE  CAB FORM 41
SCALE 1000
PUT T2, MJS, H140, H320
PUT 100 TIMES (ITEM 1) DIVIDED BY (ITEM 2)
PUT P1, MJS, 3901
PUT 0.1 TIMES (ITEM 4) DIVIDED BY (ITEM 1)
DECIMALS 0 0 1 0 2
-- TABLE ABOVE
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OPERATING STATISTICS (000)
SYSTEM MAJORS   SCHEDULED SERVICES

	RPM	ASM	LOAD FACTOR	REVENUE	YIELD
1ST 80	56,858	99,990	57.0	5,980,493	10.29
2ND 80	60,409	100,843	59.9	6,291,120	10.41
3RD 80	65,064	104,869	62.0	6,849,277	10.68
4TH 80	53,489	93,774	57.1	6,379,831	11.93
YEAR 80	235,827	399,576	59.0	25,480,721	10.80
1ST 81	50,749	92,535	54.8	6,397,012	12.61
2ND 81	58,082	97,481	59.6	7,051,820	12.15
3RD 81	61,087	98,632	61.9	7,200,978	11.79
4TH 81	51,879	92,218	56.3	6,314,472	12.17
YEAR 81	221,778	380,865	58.2	26,964,280	12.16
1ST 82	52,870	91,938	57.5	6,173,785	11.68
2ND 82	58,593	95,927	61.1	6,784,088	11.60
3RD 82	61,598	101,827	60.4	7,195,323	11.68
YEAR 82	173,059	289,792	59.7	20,163,196	11.65

SOURCE: CAB FORM 41

ON BOARD DIRECTIONAL TRAFFIC ANALYSIS

NEW YORK TO MIAMI, EASTERN

	NO. FLIGHTS	SEATS USED	SEATS AVAIL.	LOAD FACTOR	MARKET SHARE
JAN 80	414	53,160	90,909	58.5	56.5
FEB 80	384	55,074	86,812	63.6	50.7
MAR 80	411	59,187	89,891	65.8	52.3
APR 80	408	50,708	89,143	56.9	56.2
MAY 80	428	48,375	94,812	51.0	65.8
JUN 80	417	51,109	75,850	67.6	61.4
JUL 80	425	62,489	82,387	76.1	57.5
AUG 80	410	56,105	78,852	71.3	55.9
SEP 80	409	40,120	74,924	53.5	59.7
OCT 80	415	44,335	75,929	58.4	60.3
NOV 80	425	50,827	83,288	61.0	61.6
DEC 80	419	80,749	90,899	88.8	55.9
YEAR 80	4,973	632,217	1,012,891	62.4	57.3
JAN 81	418	51,240	90,229	56.8	58.6
FEB 81	384	48,942	80,912	60.5	53.2
MAR 81	425	41,887	90,805	46.0	55.4
APR 81	411	49,323	88,355	55.7	53.7
MAY 81	426	42,187	87,942	47.9	62.8
JUN 81	408	43,754	83,202	52.6	64.3
JUL 81	421	53,383	88,007	60.7	62.4
AUG 81	384	49,880	79,873	62.6	65.0
SEP 81	382	43,621	79,807	54.6	68.0
OCT 81	390	56,150	84,115	66.1	67.4
NOV 81	383	59,801	85,855	69.1	66.4
DEC 81	431	63,629	97,515	65.3	65.9
YEAR 81	4,883	605,181	1,036,317	58.4	61.7
JAN 82	406	52,904	92,043	57.5	61.3
FEB 82	380	66,378	88,789	74.8	63.6
MAR 82	422	54,079	91,817	58.9	68.2
APR 82	403	54,903	89,489	61.4	67.4
MAY 82	404	46,188	88,127	52.4	78.1
JUN 82	417	45,950	84,988	54.1	75.0
JUL 82	434	65,516	88,890	73.6	75.4
YEAR 82	2,872	385,908	624,212	61.8	68.9

SOURCE: CAB SERVICE SEGMENT DATA (ER586)

transfer Section 407 authority is desirable to clarify and simplify the program's continuation after sunset. Both DOT and CAB proposed legislative change to the past Congress to do this. We hope similar changes will be proposed to and approved by the new Congress.

CHANGES IN CAB REPORTING REQUIREMENTS

Since 1979, the CAB has conducted an open process, with public participation, of systematically studying the CAB program needs for data. A combination of the Airline Deregulation Act of 1978 and the Paperwork Reduction Act of 1980 provide two powerful reasons for this activity. The result has been a gradual reduction in reporting requirements, time phased with the gradual cessation of CAB regulatory responsibilities. A brief summary of the CAB's plans to prepare the CAB data for *sunset follows:*

1. Scaled to Size Reporting - Effective September 1, 1982, a new grouping of airlines, based on annual revenues, gives smaller carriers a break with respect to the number of forms and the detail required in those forms. For Example, airlines with annual revenue under $10 million who do not receive section 406 subsidy will file greatly simplified semiannual reports instead of the more complex quarterly B1, P1, and P5 schedules of Form 41. In addition to this provision, the CAB has waived the Form 41 reporting requirements for 22 carriers having only domestic operations and small aircraft (60 seats of less, or under 18,000 pounds cargo capacity). These airlines will file Form 298-C *instead.*

2. Form 41 Summary Reports - Of the 60 or so Form 41 reports being collected at the time of the Airline Deregulation Act of 1978, only 21 will survive until sunset. However, users of the I.P. Sharp system will be pleased to learn that only 4 of these schedules that are being or have been eliminated were in the computerized data base (P2A, P13, T3.1, and T7).

3. T6 Charter Market Data - Domestic Charter market data collection has been eliminated. Some international data will continue to be collected.

4. ER586 Service Segment Data - Although the CAB continues to need international segment data, its requirement for the domestic data is not so clear. However, the DOT advised the CAB in the fall of 1981 that "Service segment data is(sic) the most important traffic flow data source available, and is essential to DOT for developing individual and total airport programs." Now that the CAB has ensured that the data available to all carriers in a competing environment is common, at the T9 level of detail, our best guess is that service segment data will survive sunset intact.

5. T9 Nonstop Market Data - This compatible subset of service segment data will likely survive. If service segment data are reduced, it will probably be to the T9 level of detail.

COMPETITIVE ANALYSIS

NEW YORK - MIAMI (BOTH DIRECTIONS)

		1ST 82	2ND 82	3RD 82
REVENUE PASSENGERS				
IND	INDUSTRY TOTAL	612,297	406,642	408,954
AA	AMERICAN			122
BN	BRANIFF	15,131	5,081	
DL	DELTA	78	223	
EA	EASTERN	367,580	306,464	330,390
NW	NORTHWEST	4,613	2,500	2,512
PA	PAN AM	107,550	75,000	85,854
QH	AIR FLORIDA	46,210	20,310	49,280
TW	TRANS WORLD	71,117	38,332	22,707
LOAD FACTOR				
IND	INDUSTRY TOTAL	80.20	53.85	61.43
AA	AMERICAN			41.50
BN	BRANIFF	46.85	38.02	
DL	DELTA	26.62	50.57	
EA	EASTERN	85.08	57.88	63.53
NW	NORTHWEST	62.00	70.14	67.24
PA	PAN AM	53.28	38.21	48.42
QH	AIR FLORIDA	51.44	56.55	78.88
TW	TRANS WORLD	58.08	62.02	61.42
MARKET SHARE				
IND	INDUSTRY TOTAL	100	100	100
AA	AMERICAN			0.02
BN	BRANIFF	2.47	1.22	
DL	DELTA	0.01	0.05	
EA	EASTERN	60.04	65.88	67.82
NW	NORTHWEST	0.75	0.58	0.50
PA	PAN AM	17.57	18.07	17.23
QH	AIR FLORIDA	7.55	8.21	8.07
TW	TRANS WORLD	11.61	8.21	4.55

SOURCE: CAB COMBINED T9 SERVICE SEGMENT DATA

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EXTEND TO 12 82
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PUT NYC-EEEE INS TOTPAX TOTFLAGS ONLY 7 82 TO 12 82
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LABEL HISTORY SMOOTHED-FORECAST ACTUAL IN FORECAST PERIODS
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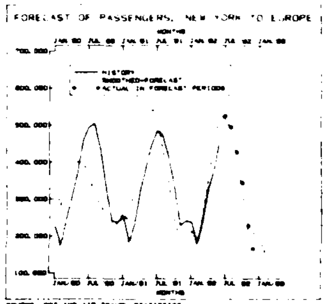

SOURCE: DOT INS AIR TRAVEL STATISTICS

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TITLE 'BY CARRIER AND EQUIPMENT TYPE'
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'=' UNDERLINE 1↑ρABOVE
PUT SUM ABOVE
LABEL '** TOTAL **'
FOOTNOTE 'COPYRIGHT 1982, OFFICIAL AIRLINE GUIDES INC.
'H' DISPLAY ABOVE
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NUMBER OF SEATS TO BERMUDA
BY CARRIER AND EQUIPMENT TYPE

C	E	1ST/82	2ND/82	3RD/82	4TH/82
AA	D10			12,900	5,187
AA	72S	29,320	50,688	33,952	21,024
AA	727				1,725
AC	DC9	1,481	3,884	2,700	2,343
AC	72S	7,487	7,330	8,812	8,026
BA	L10	41,800	42,250	42,800	38,875
DL	L10	44,243	53,326	53,039	48,345
EA	A30		2,403	20,038	2,837
EA	L10		38,100	18,330	15,238
EA	72S	55,770	58,844	48,952	54,708
PA	72S			3,900	12,144
PA	727		1,830	7,284	
QH	737	1,947			
** TOTAL **		175,488	250,520	298,381	208,710

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6. O & D Passenger Origin and Destination Survey - As with service segment data, the DOT has called for continuation of the survey in its present form. A rule under consideration at the CAB will eliminate dollar-amount-of-fare data and reduce fare basis codes.

7. Form 298-C Small Aircraft Operation Reports Since these data are valuable to the essential air service program, they will likely survive. Some carriers, which achieved certification after deregulation, but which operate small aircraft, will be placed back in these reporting systems.

8. Form 291 Domestic All-Cargo Data - Slated for elimination.

ALTERNATIVE DATA SOURCES

During the past four years, budget constraints have forced an information staff reduction of over 50 percent at the CAB. This has occurred during a time when the number of newly certificated airlines filing reports with the CAB has almost tripled. To guard against this vulnerability of staff cutbacks, the CAB has explored the use of private sector firms to process CAB aviation data without charge to the Board. I.P. Sharp, Associates is pleased that the CAB has seen it appropriate to rely on its services and staff to assist in the processing of CAB Form 41 financial and traffic reports for validation and publication purposes. For example, for the past year, CAB's quarterly publication "Air Carrier Financial Statistics", or the "yellow book", has been created using the I.P. Sharp Form 41 data base. The fact that the CAB assists in the update cycle of the data base has generally resulted in a much more accurate, timely, and complete Form 41 data base for all users of the data.

But the CAB data base is not the only source of data available to the aviation analyst. On the I.P. Sharp system, the following data bases have proven popular:

OAG - The Official Airline Guide - a complete history of the schedules of all airlines in the world since January, 1979. Recent additions to the data base make it quite simple to use the data to analyze flight itineraries, seats flown, and ASM's.

INS - U.S. International Air Travel Statistics a data base provided by the DOT which shows traffic patterns for all international air travel to or from the U.S. (except Canada).

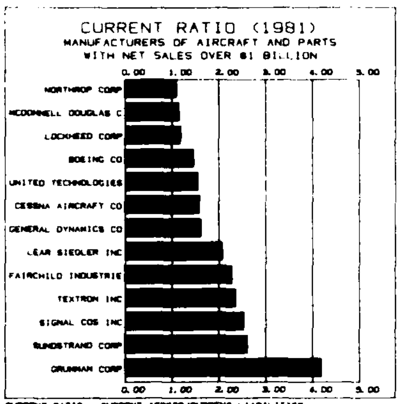
AEA - Association of European Airlines - a data base similar in scope to the CAB Form 41 data base. Certain portions of this data are available to non-AEA members.

ICAO - International Civil Aviation Organization - a data base containing traffic statistics for most major airlines of the world.

Other related data bases which might prove useful to the analyst which are available via the I.P. Sharp time sharing system are: USSTOCK, a data base containing 5 years of daily trading

statistics for all U.S. securities; DISCLOSURE, a data base containing the 10K reports for companies which file with the SEC; CITIBASE, a data base of economic data; and UNSITC, a large data base from the U.N. containing annual and quarterly trade statistics for over 3,000 commodity codes.

Examples highlighting the content and use of these various data bases follow:



CURRENT RATIO = CURRENT ASSETS/CURRENT LIABILITIES
SOURCE: DISCLOSURE II/SEC

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CLEAR
TITLE  KEY U.S. ECONOMIC VARIABLES
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MONTHLY,DATED 1 81 TO 1 83
AVERAGES
LABEL  CONSUMER PRICES,PRODUCER PRICES
LABEL  UNEMPLOYMENT RATE,PRIME RATE,HOUSING STARTS
FOOTNOTE  SOURCE  CITIBASE
  M  TABLE CITIBASE  PZU,PW,LHUR,FYPR,HSFR
```

KEY U.S. ECONOMIC VARIABLES

	CONSUMER PRICES	PRODUCER PRICES	UNEMPLOY RATE	PRIME RATE	HOUSING STARTS
JAN/81	260.50	284.80	7.50	20.16	1.588
FEB/81	263.20	287.60	7.40	19.43	1.278
MAR/81	265.10	290.30	7.30	18.05	1.303
APR/81	266.80	293.40	7.20	17.15	1.332
MAY/81	269.00	294.10	7.50	19.61	1.150
JUN/81	271.30	294.80	7.40	20.03	1.047
JUL/81	274.40	296.20	7.20	20.39	1.039
AUG/81	276.50	296.40	7.40	20.50	949
SEP/81	279.30	295.70	7.60	20.08	900
OCT/81	279.90	296.10	8.00	18.45	868
NOV/81	280.70	295.30	8.30	16.84	839
DEC/81	281.50	295.80	8.80	15.75	808
JAN/82	282.50	298.30	8.60	15.75	877
FEB/82	283.40	298.60	8.80	16.56	911
MAR/82	283.10	298.00	9.00	16.50	920
APR/82	284.30	298.00	9.30	16.50	911
MAY/82	287.10	298.60	9.40	16.50	1.028
JUN/82	290.60	299.30	9.50	16.50	910
JUL/82	292.20	300.40	9.80	16.26	1.185
AUG/82	292.80	300.70	9.90	14.39	1.046
SEP/82	293.30	299.30	10.20	13.50	1.134
OCT/82	294.10	299.90	10.50	12.52	1.142
NOV/82	293.60	300.40	10.70	11.85	1.361
DEC/82	292.40	300.60	10.80	11.50	1.253
JAN/83		300.00	11.40	11.16	1.718

SOURCE CITIBASE

AVIATION DATA BASES

CIVIL AERONAUTICS BOARD
- FORM 41
- ER586 SERVICE SEGMENT
- COMBINED T9/SERVICE SEGMENT
- ORIGIN-DESTINATION
- COMMUTER ORIGIN-DESTINATION

DOT/INS - U.S. INTERNATIONAL TRAVEL STATS
OAG - OFFICIAL AIRLINE GUIDE
AEA - ASSOCIATION OF EUROPEAN AIRLINES
ICAO - CARRIER TRAFFIC STATISTICS
AISL - AIRCRAFT ACCIDENTS

OTHER RELEVANT DATA BASES

CITIBASE - U.S. ECONOMIC DATA, CITIBANK
NPA - NATIONAL PLANNING ASSOCIATION FORECASTS
COMMODITIES - NEW YORK, CHICAGO, LONDON
USSTOCK - 5 YEARS DAILY SECURITY DATA
DISCLOSURE - 10K REPORTS FILED WITH THE SEC
CURRENCY - DAILY FOREIGN EXCHANGE RATES
DOE - PETROLEUM STATISTICS
API - WEEKLY STATISTICS BULLETIN
LUNDBERG - GASOLINE PRICES BY CITY
PIW - PRODUCTION, PRICES OF CRUDE OIL

LUNCHEON ADDRESS

INTRODUCTION BY THOMAS MESSIER

Michael K. Evans is with us to give us a luncheon speech. It turned out that he made the same mistake that several people did earlier today and went to the wrong Hyatt Regency.

Mike is president of Evans Economics, Inc. of Washington, D.C., an economic forecasting and consulting firm which he founded in 1979. Certainly he is one of the nation's foremost econometricians. He was the founder and former President of Chase Econometric Associates, Inc. which is presently a wholly owned subsidiary of Chase Manhattan Bank.

In addition to preparing more than one hundred and forty successive monthly macro forecasts, Dr. Evans has undertaken numerous consulting projects for corporate and government clients. He has also testified frequently before Congressional committees on the economic input of tax legislation. I am not sure they have always listened.

Dr. Evans is a contributing editor to Industry Week for which he writes a regular bi-weekly column. He is also a member of the Los Angeles Times Board of Economists and a frequent contributor to the Wall Street Journal and New York Times. He appears often on both the Today Show and Wall Street Week.

Mike is a native of Cleveland. He completed his under-graduate and graduate work at Brown University and received an A.B. in Mathematical Economics in 1960 and a Ph.D in Economics in 1963. I am very pleased to introduce Dr. Michael Evans.

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Michael Evans
Chief Economist
McMahon, Brafman,
Morgan & Co.

I didn't really go to the wrong Hyatt. That was just a cover story. I told them when I sat down at lunch, "I'm going to address people that have something to do with the airline industry and I want to make them feel at home, so I figured I better arrive a half hour late."

I am told this is strictly a forecasting conference today and I do want to talk about the state of the economy over the next few years. Clearly, the news has been very good recently. Not only the increase in the durable goods new orders and the decline in unemployment and increase in production but, of course, the decline in oil prices which is now spreading rapidly throughout the system. It appears that, clearly, 1983 will be a much better year than we have had in the past 4 years.

I refuse, however, to go along with those people who are getting terrifically wound up and excited about 1983 and are saying that they don't see any reason why we can't have the boom proportions that we usually have.

In the first year of recovery, the first four quarters, real GNP traditionally increases about 6 to 7 percent. I just don't see that happening. I think we are going to see an increase of probably about 3 percent during the four quarters of the year.

I thought that for once I had agreed with the forecast put out by the Council of Economic Advisors for the first time in 20 years. But I figured it was all right. I guess, as soon as Marty Feldstein saw my forecast, he decided to raise his, so I can report that we are still apart.

I don't think that the optimism, the excessive optimism, is warranted. There are still a lot of problems with the economy and the fact that oil prices have come down on balance will not add to real demand this year. Clearly, in the longer run, it is a good thing. Just as clearly, in the longer run, an increase in oil prices had a negative effect both on domestic and international GNP.

There are as many negative factors in the short run as in the long run. If you had been down in San Antonio, or Odessa, you would appreciate this, the fact is that the whole oil service industry is going to find itself in a position of lower demand. People who depend on the oil industry for revenues are going to find themselves with lower income and that will balance off the fact that we have more income in the pockets of consumers.

I don't look for the oil price decrease as being the equivalent of an excise tax cut as some economists have suggested. In fact, if you go back and look at what happened when we had the two energy shocks, you will find that economists completely mis-forecast what was going to happen. You might say, what's unusual about that? It happens every year. We don't need an energy shock for that to happen.

But actually what happened was that all economists, including me, went out and said the higher oil prices have the same effect as an excise tax - take money out of people's pockets, but us into a recession, and so forth and so on. Eventually, we had the recession but the initial impact of the oil shocks was actually to have an increase in GNP. What happened was that there was an increase in investment. The oil communities stock piled inventories. What finally choked off what was going on in terms of the continuing growth of the economy was the fact that higher inflation led to higher interest rates which had the predictable effect on the economy that it always does.

What I am trying to say here is that the major beneficial effect of lower oil prices will eventually work through lower interest rates, but that's not happening right away either. We have had some movement in the market in the last couple of days as interest rates have come down a bit. But I certainly think it is going to take the Federal Reserve Board a while to act, and it will take the markets a while to act before we actually have some substantial declines in interest rates which follow the decline in oil prices. I don't really see the benefit to this accruing to real GNP until 1984 when, I think, we will have a pretty good year.

As far as outlook goes for 1983, we do have to come face to face with the negative elements as well as the positive elements which are inherent in the forecast. The capital spending, for example, is going to continue to decline this year. The Commerce Department survey, which was released a couple of months ago, showed that real capital spending would be down 5 percent this year. My own figure is about 7 percent, but we are not talking about huge differences, we are talking about fine tuning. Whether it is down 5 or 7 percent, if you go back and look at your business cycle history, you will find out that in the first year of recovery, capital spending generally increased in real terms and never went down more than one percent. We are talking about a very substantial decline in capital spending going into the recovery, which has never happened before.

The reasons for this are pretty obvious. Real interest rates still are very high, after all. On historical standards, with the rate of inflation about 4 percent, we ought to have

short term rates, federal fund rates, commercial paper rates, and so forth, about 4 percent. We ought to have the prime about 6 percent, mortgage and bond yields maybe 7 percent.

Well obviously, they are about 5 percent higher than that. Instead of a prime of 6 percent, we have one at 11 percent; we have bond yields of 12 1/2 percent; we have mortgage at 13 percent and so forth and so on.

So, real interest rates are still exceedingly high by any reasonable historical standards. You have to ask yourself why interest rates are so high. Well, I guess the gut reaction is that the deficit is so big. Well, certainly the deficit is big and it is going to get larger. It is not only the deficit, it is the fact that the financial markets don't believe that the low rate of inflation is here to stay. Unfortunately, I have to agree with them in that respect, as I will mention a little later.

But whether it is expectations, or whether it is the deficit, the net effect is the same. Interest rates in real terms are about 5 percent higher than what we would ordinarily expect. They probably will stay there for the year. My forecast for interest rates for the year is very little change in either direction.

This, of course, is certainly going to hurt capital spending. The fact that the profit margins in 1982 were at a 40-year low is bound to hurt. The fact that capacity utilization was the lowest since they have kept the figures is bound to hurt. And the fact that there just has been a change in the way management makes business decisions is bound to hurt. Now every time we go through a recession, of course, it is a time for housecleaning and businesses cut out the fat, or what they claim was the fat, and they postpone their decisions and stretch it out.

This is the first recession we have ever gone through where decisions were made to cut out whole layers of management. The result this has on capital spending, for the most part, is that the routine decisions to buy a piece of equipment, at $50,000 or less let us say, which used to be made by relatively low middle management, has been kicked up to a higher level where, at least for this year, it is bound to get postponed.

The effect of housecleaning on the part of businesses has been to postpone capital decisions even further. So, all these factors contribute, of course, to a decline in capital spending.

In addition to all the postponements on capital spending issues, the fact is that businesses are going to be very slow at hiring back workers. Even more slowly than they usually do.

Now I realize that the decline of 0.4 percent in the unemployment rate in January is really antithetical to this and it would appear that unemployment is going to decline further. But, I don't buy that argument. The January number was based almost entirely on statistical flukes. My forecast for unemployment is that it will back up slightly in February, perhaps to 10.4 percent and then for the rest of the year the growth in employment, and the growth in the labor force will be approximately the same -about 150,000 per month. And so the unemployment rate will still be about where it is which is to say about 10 percent by the end of the year.

I think that the idea that businesses are very cautious about hiring workers back is much more in line with what's going on than the January numbers which were based primarily on seasonal problems with the data.

Another area which is weak clearly has to be net exports. During the last two quarters, net exports dropped 25 billion dollars. Why? Because, obviously, the overvalued dollar cut into our exports. The fact that the world economy is so weak didn't help. But net exports will continue to decline throughout the year. This is a very serious problem. One which is obviously endemic to the economy, and, one which is not going to go away when we have an upturn. In fact, if anything, we are going to import more during our upturn. We can look for net exports to be weak, not only in this year but for several years to come.

On the brighter side, housing starts are now likely to average about 1.5 million units this year, up almost 50 percent from the levels of 1982. That has to be a big plus and that's somewhat more optimistic than most forecasters, including myself, were looking for a few quarters ago.

Basically, we've skirted all the issues and we haven't come to the two-thirds of GNP which is represented by consumption. This is clearly the swing item. I've heard so many people talk about a consumer-led recovery, it's almost like it's a generic term. What other kinds of recoveries are there? But, I think we have to define what we mean by a consumer-led recovery. What does this mean? The way I see it, a consumer-led recovery basically means that the saving rate goes down. The consumers spend more out of every dollar. If consumers continue to spend the same amount out of every dollar, then that isn't a consumer-led recovery, because that means that more dollars in either higher real wages, or higher employment, has to come from some other sector. That could be investment, or net exports, or government spending, or housing, or something else. I've just indicated that, on balance, I don't think these other sectors are going to supply very much in the way of growth for the economy. So a consumer-led recovery, to have any logical meaning to me, means the savings rate goes down. It could happen. I'm not saying it won't happen. I will point out that, in the past five recoveries that we had, the saving rate has stayed constant or has gone up. The usual theory of consumer behavior says the saving rate does rise in booms and does decline in recessions. The past patterns are not necessarily indicative of what's going to

happen. Forecasters have to do a better job than simply looking at past patterns and not taking into account what is going on today. I certainly agree with that. I just want to point out what the history looks like.

But, in addition to that, I think the consumer is a pretty unlikely candidate for decreasing the saving rate this year. The consumer is (A) scared, and (B) broke. These are not generally the conditions that you see when you go into a consumer-led recovery.

As far as scared goes, the unemployment rate was down in January, but it is still above 10 percent. It has not been there since 1940. Most consumers are very unwilling to go into debt to buy a big ticket item because they are worried about their jobs and, also, because buying things on credit right now is a lousy idea. In the 1970's, it was a great idea. We had interest rates at 10 percent and we had inflation at 9 percent. Of course, half the interest rate was deductible, so your basic rate of interest was something like minus 4 percent. It paid to go into debt to a certain extent.

Now we have inflation of 4 percent and we have consumer loan rates starting at 12 percent if you buy a new car; but, actually, it is in the 16 to 18 percent range. Even after your deductibility, the real rate of interest for consumer borrowing is something like plus 5 percent. Prices are going down rather than up.

In the late 1970's, we had a fair amount of the syndrome: "Buy it now because it will cost more later." Now, we have almost the reverse syndrome: "Don't buy it now because it will cost less later." So we have absolutely no incentive to buy now as an inflation hedge or to buy now because interest rates are cheap. The so-called postponable items can easily be postponed another year.

I don't think the optimism of consumers is anywhere near the point where it is going to lead to a consumer boom.

As far as being broke, basically, real disposable wage and salary income has declined about 8 percent over the last 4 years. The personal income statistics are very misleading. Personal income in real terms has continued to grow. However, the reason it has continued to grow is because of the personal interest income component.

For practical matters, the personal interest income component has nothing to do with consumption. We take it out of our functions completely when we are estimating consumption.

First of all, it represents accrued interest on savings deposits. You can't tell me that, because the money market fund rate went up last month, people are going to run out an buy more goods and services. It just doesn't work that way.

Secondly, a personal income number is largely an imputed number. Look at the amount of interest income that is in the accounts and compare it with the amount of interest income that is taxable. I know there is a slippage because of municipal bonds but you are off by a factor of 3 to 1. Most of the personal interest income is just an imputed number - a made up number - and the higher interest rates go, the larger that number gets whether consumers ever see any of it or not.

All I'm saying is you really have to take that number out when you look at the figures of what consumers have to spend. You find that number has gone down 8 percent over the last 3 years.

Consumers are not in very good shape. Real wages, I think, will show very little increase this year; employment will rise perhaps 1 1/2 percent as I have indicated, but that in itself is not enough to fuel a consumer boom.

As far as the tax cut goes, I think we are all sick and tired of hearing about what great things the economy is going to do because of the tax cut. We heard them in the fall of 1981 when the economy went into a recession; we heard them in the summer of 1982 when the economy continued in recession.

There are two facts to point out. First of all, for the average worker the tax cut is $5 a week. You can't convince me that that's going to make the difference between buying a car or taking a vacation. The second thing is that if you look at the ratio of personal income taxes and social security taxes paid by individuals to total wage and salary income, this ratio in 1980 was 31.3 percent. In 1983, after the third stage of the tax cut goes into effect, assuming it does so on schedule, this ratio will have risen from 31.3 percent to 31.6 percent.

In other words, the whole tax cut has been wiped out by higher inflation, bracket creep, and higher social security payments. Of course, that doesn't mean the tax cut is necessarily a bad thing. It is clear that if we hadn't had the tax cut we would have had an even higher proportion of income that went to taxes. All I'm saying is that the great purchasing power that is allegedly coming from the tax cut is a myth. The tax cut was supposed to be sold on the idea of supply side economics, which nobody ever talks about anymore, but the idea was that the tax cut would improve savings. It would improve productivity. It would improve work incentive. Whether it does that or not, it was never supposed to be sold on the basis of the fact that it would be more money in the pocket of the consumers. And once the Reagan administration switched to that tactic, they lost, anyhow.

So, I don't think we're going to have a consumer-led recovery. There will be growth in the economy, the 3 percent growth I have talked about in which housing is a strong sector; there is some rebound in inventories; there is the usual increase in consumption of non-durables and services which is sort of a trend factor. But that's about it. We really have to wait till 1984 to have the big boom start.

The interest rate picture is positive, not totally because of the oil situation, although that helps, but because there is no particular

reason for rates to rise under this rather moderate to anemic recovery. I will say this. If the economy really started to take off, if it rose 6 percent to 7 percent as is often the case in the first year of recoveries, then I think the recovery would have collapsed of its own weight two or three quarters from now. The international monetary system, as well as the domestic monetary situation, are still too far out of balance to support a sustained rise at the moment. I think we are actually better off with an anemic recovery than we would be with the beginnings of a boom. After all, when the boom started in late 1980 that turned into a recession. Then, we had a little bit of recovery in mid-1981, and a little bit in mid-1982. But, they just didn't pan out.

I think that we have to realize that the financial constraint is still in place. If I have one sentence that is written above all my forecasts, that would be it. The financial constraint remains in place. And as long as that is the case, I don't think we are going to get very far by having a big boom.

By the time we get to 1984, we should begin to have some more positive signs of growth. Capital spending, I believe, will turn around in 1984. In real terms, I would expect it to be up about 5 percent. The big increase in housing will have come this year and housing starts next year will probably only inch up marginally, maybe to 1.6 million from 1.5 million this year. Exports will continue to decline; consumption will be a little stronger because businesses will be hiring more people back.

So 1984 looks like a growth rate of perhaps 4 to 5 percent. That doesn't sound too bad. In fact, considering where we have been from 1979 to 1982 with a growth rate that totalled somewhere in the neighborhood of zero percent, 4 to 5 percent sounds pretty good.

I don't really know if it will be viewed that way by the people who count in this case, who are the voters. Because, basically, what we have to have is a 3 percent rate of growth just to keep the unemployment rate stable. The reason for that is actually fairly straightforward. Productivity is probably growing at about 1-1/2 percent a year. So your first 3 percent of growth in GNP is offset by labor force and productivity growth and your unemployment doesn't go down at all.
After that, for every 1 percent the economy grows, using the old rule of thumb, unemployment drops by about 1/3 of a percent. The latest economic report of the President has changed that, so that every 1 percent that GNP grows, unemployment drops by about .44 percent. That helps their long range projection considerably.

I don't think there has been much of a switch. But whether we are talking about 1/3 of a percent or .44 of a percent, even if the economy grows 4-1/2 percent in 1984, which would actually be the top of my forecast range, we are still going to end up with an unemployment rate going into the election at right around 10 percent. I don't think the voters are going to stand for it.

In fact, I think the Reagan Economic Program, which is none too popular at the moment, will become increasingly unpopular as the election approaches. After all, suppose Reagan weren't President right now. Suppose Congress could just vote up or down on fiscal policy. What do you think they would vote for? First, they would vote for no third stage of the tax cut. Second, they would vote for no "indexation" of taxes starting in 1985, they would kill that program. Third, they would vote for an increase in defense spending of no more than 5 percent a year in real terms and perhaps 3 percent or 4 percent. Fourth, they would vote for job bills and I don't mean $4.3 billion, I mean $15 or $20 billion. Fifth, they would vote to basically restore most of the welfare programs that have been cut. Sixth, they would vote for further incentives to investment for infra-structure and for key industries like steel, autos and things of that sort. They might also vote for protectionism, but I am not sure about that. I'm going to leave that aside.

Those six items are basically what I believe to be the consensus fiscal policy of the U.S. and such a program would obviously be vetoed from day one by President Reagan, so it won't be voted on. But I think that's what the people would like to vote on.

So as we go on to 1985, with the unemployment rate at 10 percent, with a Democratic Congress and probably with a Democratic President, I think we are going to see a program like that initiated.

The net effect of such a program will be more heavily centered on increased spending than it will be on tax increases. On balance it will be stimulative. On balance it will be accompanied by easier monetary policy, a decline in real rates of interest and, therefore, on balance it will be inflationary again.

We have to be very careful when we talk about inflation. Some of the inflation estimates have gotten carried away by the price of gold and silver in the last couple of months and they have said, as soon as the recovery starts, inflation is going to come back. That is actually a very bad forecast. Inflation is not going to take off this year. It is easier for me to say so this week now that oil prices have dropped. I have actually been saying this for quite some time.

The fact of the matter is that if you go back and look again at your business cycle history, inflation does not drop during recession, inflation drops during the first year of recovery. The reason for that is obvious if you think about it. Wage rates which are based on last year's unemployment are modest. You get a big increase in cyclical productivity when the upturn starts. You obviously don't have any bottle necks and shortages when you're just beginning a recovery. All these factors point to a rate of inflation this year which is going

to be 4 percent or less. You might say the rate of inflation last year was 3.9 percent. It wasn't really - that's just because of the mortgage rate which they've gotten rid off. The X-1 series for the CPI was 5.1 percent last year and that's about what inflation was. It'll be 4 percent or lower this year and inflation will also stay low in 1984. Again, wage increases will be relatively moderate. The improvement is cyclical; productivity will be substantial, and so forth and so on. So we're talking about inflation of 4 percent or less this year, and I would say, next year, 4 to 5 percent. It could easily be 4 as well as 5 percent. It won't be higher than that.

So by that time, what I'm trying to say is that the inflation pessimists will be roundly defeated and people will say that inflation is no longer the problem. Let's get the economy moving again. All the cliches we've heard. Fritz Mondale gets up there and he says, "We've rebuilt Germany and we've rebuilt Japan. Now it is time to rebuild the United States." I'm not predicting Mondale is going to win but whoever is up there is going to say something like that. "It's time to rebuild the United States after we've done all these marvelous things for the rest of the world."

So we'll see stimulative policy and just about that time, the third year of recovery, is traditionally when inflation starts to kick in again. And of course, it doesn't happen overnight, it never happens that way. But we'll move up to a rate of inflation of maybe 6 percent in 1985, which will be considered tolerable and an increase above that, which should go back to 8 percent or 10 percent, but it's very hard to say because it depends on exactly what fiscal or monetary policies are followed. And besides, it's still five years off. When we get out in the late 80's, nobody is sure what's going to happen in terms of policy by then. But the point I'm trying to make is that inflation will come back and the reason that it will come back is that we have solved none of our fundamental problems. I don't expect inflation to be back to 13 percent as it was in 1980 because that coincided with the second energy crisis and with all the other factors. I think that oil prices, in real terms, are going to remain stable for many years now. We may have a slight kickback from the drop that was just announced, but, in general, oil prices are certainly not going to be any higher in real terms in 1987 than they were in 1982. And my guess is that they will be somewhat lower in real terms. So we're not going to have a third energy shock unless some madman blows up the Strait of Hormuz.

But, basically, from an economic point of view, we have the gap between the 31 million barrels per day that OPEC used to produce in 1979 and the 17 million barrels per day that they're producing now. It would take a tremendous amount of demand to fill that gap. And, I do not see it forthcoming . So we don't have an energy crisis propelling it. We have the generally higher wage rates, higher prices, higher profit margins, and so on - gradually pushing prices up. And the key, I would say is that productivity has really not improved.

The whole point of the Reagan program - and I know it's in shambles now and it's fashionable to look back and say I never believed any of the garbage and so forth - is that both Democrats and Republicans agreed that productivity was a major issue. We had to do something about turning productivity around. After all, productivity used to grow 3 percent a year, and in the last days of the Carter Administration it was actually declining. Both Democrats and Republicans prominently identified several of the sources. There wasn't enough investment and saving, there wasn't enough incentive on the part of labor and capital because of high taxes. Government spending, as a proportion of GNP, was 23 percent. It ought to go down and, as I say, both Democrats and Republicans thought it should go down to about 20 percent; although, obviously, there were some differences in the mix that was to be used.

What has happened is that the government spending to GNP ratio in the two years that Reagan has been in office has gone to 26 percent. That is not a partisan statement one way or the other. It is just a simple fact.

You could argue the mix is different - part of it was due to the recession and so forth - but the fact of the matter is that the ratio has continued to rise and none of the underlying engines of growth in government spending - social security programs, medicare programs, etc. - have been touched in any way, shape or form.

The investment ratio which was clicking along - this is capital spending to GNP - was pushing along at about 13 percent which was considered way too low but has now dropped to 11 percent and, as far as I can tell, it will probably stay there for the next 3 or 4 years.

The net saving rate - the worst of all - which averaged 6 percent over most of the post was period declined to less than 1 percent last quarter. As far as I can tell, it will stay at less than 1 percent this year.

It is not that consumers, per se, are saving less - they are actually saving somewhat more. But the 6 percent personal saving rate is all being gobbled up by the government deficit which, this year, is running about 6.5 percent of GNP.

The basic underlying problem of the high spending ratio, the low investment and savings ratios, and the high tax rate is that very little has been done. The tax rates have been lowered relative to what they would be but, as I say, when we get back into 1985 we will see higher tax rates again.

So without the problems of productivity solved, I don't see any reason to expect that we can have a lon term solution with low inflation? if you want to keep the unemployment

rate at 10 percent, it is not that hard to keep the inflation rate at 4 percent, although even that implies a so-called rule of 14, whereas, in the 1950's and 1960's, we had a so-called rule of 8. So 14 isn't such a great experience either.

The fact of the matter is the 10 percent unemployment rate is impossible politically and so the result of that is we will see attempts to lower it, which will be successful, but only at the expense of higher inflation.

We have not gotten rid of the trade-off between inflation and unemployment at all. The only thing you can do about that, in my opinion, is to increase substantially the underlying growth rate and productivity. Although we have a slight cyclical upturn in productivity, it will accomplish nothing of the sort.

So the news is good today in terms of the increase in the January statistics, and certainly in terms of lower oil prices; neither of these was a fluke, because I expect the economy to keep growing, although at a moderate rate, and prices to stay down for at least 2 years. Yet we still have to be very cautious of getting too excited either about the chances of a very robust recovery in 1983 or the return to balanced low inflationary growth in 1984 and later years. The underlying problems of low productivity, saving and investment still remain with us.

PANEL II

GENERAL AVIATION
FORECAST MODELS

1977 Cessna 310

INTRODUCTION

DR. SCHWARTZ: My name is Arnold Schwartz and I am the moderator for the general aviation panel. During this session, we are going to hear 3 very interesting papers on general aviation. The first concerns the application of a durable goods sales model to general aviation aircraft. The second deals with the use of statistical sampling techniques for estimating operations at non-towered airports. The third will be about general aviation in Canada.

I would appreciate it if you would please hold your questions until all the panelists have finished their presentations.

The first participant is Dr. Jerry Fairbairn. Dr. Fairbairn is an Associate Professor of Aeronautics at San Jose State University where he teaches in the area of Aviation Business Management and Flight Operations. Dr. Fairbairn received his Ph.D. from the University of Santa Clara, where he studied Business Administration, and did his Doctoral Dissertation on the General Aviation New Airplane Sales Cycle. He has been active in the General Aviation Industry for the past 20 years and is a certificated Air Transport Pilot, Flight Instructor and Air Frame and Power Plant Mechanic. I would like to present Dr. Fairbairn.

A DURABLE GOODS SALES MODEL WITH AN APPLICATION TO GENERAL AVIATION AIRPLANES

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University

SUMMARY

Dr. Fairbairn begins by disassociating the decrease in general aviation airplane sales from the general economic downturn. Instead, he posits a cyclical model for airplane sales based on two premises: first, that general aviation airplanes are a durable capital good exhibiting a low rate of depreciation, and second, that the average yearly use of airplanes does not change radically over time. This leads to the "accelerator effect," i.e. a small increase in the demand for the services that the durable good provides creates a disproportionately large increase in the demand for the good. Thus, general aviation sales tend to follow cycles driven by the accelerator effect subject to inertial adjustments.

INTRODUCTION

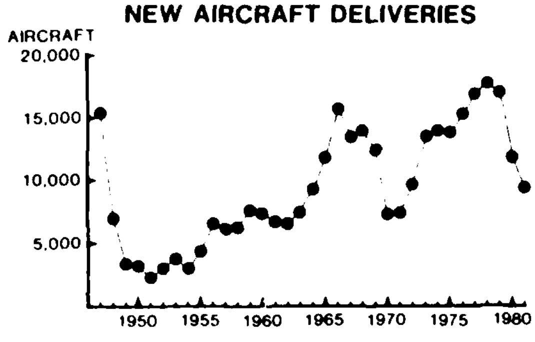
Thank you very much Dr. Schwartz. It is a pleasure being here. There is always excitement associated with new airplanes. Manufacturers innovate, introduce new technology, change paint designs, and plush up the interiors each year to sell the public on new airplanes. They advertise these airplanes heavily and attract a great deal of media attention. Figures on new airplanes sales are compiled monthly by the General Aviation Manufacturers Association and are published in a variety of places. As with most other durable goods the sales tend to follow the overall economy, but the cycles are normally of greater magnitude. An examination of Figure 1 provides a basic feel for the highly cyclical nature of airplane sales since just after World War II.

There is always hope by those involved in airplane sales that the upward side of the cycles will keep getting stronger and the downward swings will weaken. In 1979 the popular aviation magazines were quoting airplane manufacturers as saying that the general aviation industry had matured, that it was much less susceptible to economic cycles than in the past, and that the reasons for using general aviation airplanes were so sound that new airplanes would continue to sell even with the expected economic downturn.

This may have been an effort to keep sales people in a positive frame of mind, but apparently some of the manufacturers really

FIGURE 1

NEW AIRCRAFT DELIVERIES



believed it. Moreover, there were a number of factors to support the belief.

Airplane sales during the preceding nine years had grown at a relatively steady pace, going from a depressed flow of 7,100 units in 1971 to 17,048 units in 1979. Based on previous experience, this time period did not appear to exhibit conditions favorable to steady growth. The fuel shortage in 1974 had only briefly interrupted sales, and the increase in the price of fuel did not seem to have a serious impact. The ensuing deep recession in 1974-75 also seemed to have little effect. Through the rest of the 1970's the price of fuel continued to increase, interest rates rose, and new airplane prices increased, but none of these factors seemed to hurt airplane sales seriously. Finally, an industry that was usually a leading indicator of recessions did not turn down, even with the first real signs of the long awaited recession in late 1979.

However, in spite of their hopes, the downturn came and sales fell from the high of 17,048 units in 1979 to 4,266 units in 1982. Hundreds of fixed base operators (FBO's) gave up their sales franchises and even some distributors quit. In this presentation, I hope to show why the the downturn in sales was inevitable and would have occurred even without the prolonged recession we have experienced over the past two years. The emphasis will be on a descriptive model of the dynamics of the new airplane sales cycle which can be used to help people see why

variations in sales occur, and which can be used to allow a comprehensive analysis of the cycle.

BACKGROUND

In order to understand the new airplane sales cycle, it is important to understand the basic forces which drive the cycle. One of the most important factors that must be recognized is that airplanes are a capital good used in the production of a service. The basic service that is demanded in general aviation (GA) is hours of flight time or miles of air transportation (which is highly correlated with hours of flight time). The capital good is the stock or fleet of airplanes needed to produce these hours of flight time. The Federal Aviation Administration (FAA) currently estimates that 42.6 million hours per year are flown in GA with a stock of 213,100 active aircraft. Obviously hours of flight services are not all that airplanes produce, particularly new airplanes. Airplanes provide prestige, status, and ego gratification. They may provide a tax shelter. Some people own an airplane just because they like working on them and keeping them in excellent mechanical condition. However, these are all secondary uses and would not be adequate justification for most people to own an airplane, if they could not use it for its primary purpose which is hours of flight time.

The basic demand in GA is for a stock of airplanes which are used to produce hours of flight services. New aircraft are needed to replace aircraft in the stock that are destroyed, to replace productive capacity that is lost through normal airplane deterioration, and to adjust the size of the stock as demand for services changes. All of these are determinants of the demand for new airplanes, but the airplanes needed to adjust the size of the stock is the factor which causes sales to be highly cyclical. Several examples will be used to illustrate the reason for this, but it is first necessary to make two important points relative to the ability of airplanes to produce flight time. One is that the average hourly utilization of airplanes does not change radically over time. The FAA's estimate of hourly utilization over the past twenty years indicates that this rate averages just under 200 hours per year per airplane. This rate of utilization probably increases when demand for hours flown increases, but is then brought back in line with the addition of new airplanes to the stock. Similarly, when demand for hours flown decreases, the utilization decreases and inhibits sales of new airplanes until the stock has declined to the appropriate size.

The second important observation is that the hourly utilization of an airplane decreases as it ages. The rate varies from about four percent per year for multi-engine airplanes to ten percent per year for basic single-engine airplanes. This may be because newer airplanes are generally more reliable and are capable of a greater number of hours of operation than older airplanes, or it may be that the greater fixed costs associated with new airplanes allows them to be used only in situations where high utilization is possible. In any case, using data on hours flown by airplanes of various ages indicates there is a steady decline in the hourly utilization of airplanes as they become older. Because of this and because the size of the stock of airplanes is to be measured in terms of its productive capability, it is necessary to weight airplanes of different ages by their utilization relative to that of a new airplane. If on the average a ten year old airplane is only used half as much as a new airplane, then it should only be counted as one-half an airplane when determining the size of the stock. Future references to the stock of airplanes will refer to the number of airplanes weighted by the average number of hours flown by airplanes of the appropriate ages relative to new airplanes.

It is now possible to construct some examples that show how variation in the demand for flight hours would affect new airplane sales. In order to simplify the examples, it will be assumed that average hourly utilization of airplanes remains constant and that the stock of airplanes loses eight percent of its productive capacity each year. These rigid assumptions will be relaxed at a later point.

For these examples, assume that initially the number of hours demanded remained constant over several years so that demand for new airplanes stabilized at a rate which provided only enough airplanes for replacement. With 100,000 airplanes (new airplane equivalents) and an average rate of depreciation of eight percent per year, it would take 8,000 airplanes to provide for replacement. If, due to growth in the economy, the number of hours demanded grew by just five percent, then the stock of airplanes needed would grow five percent, or 5,000 airplanes. When this is added to those needed for replacement, the total number of new airplanes needed would jump from 8,000 to 13,000. That is over a sixty percent growth in the number of new airplanes demanded. Additional examples could be used to show that any time there is even a moderate change in the demand for flight hours, there is an exaggerated change in the same direction in the number of new airplanes needed. This is referred to as the accelerator effect and is common to all durable goods industries. It tends to be strongest where there is a low rate of depreciation, such as with airplanes, and a relatively fixed output capability of the durable good.

In the preceding example, it was assumed that the output capability of airplanes was fixed. Of course, as mentioned earlier, there is some flexibility in this rate. This flexibility tends to soften the shifts in demand for new airplanes and allows the sales of new airplanes to increase at a smoother rate.

It may be helpful to think of the flow of new airplanes as having a certain amount of inertia. If sales have been at a certain level for a period of time, they will tend to remain at that level even though a higher rate of sales is needed to expand the stock of airplanes to its ideal size. In the preceding example, the hours flown had been constant for a number of years and the flow of new airplanes into the stock had stabilized at 8,000 airplanes per year. Then, due to growth in the economy, there was an increase in the number of hours flown and thus a need to expand the fleet by 5,000 airplanes. To meet this need total production needed to shift from 8,000 airplanes to 13,000 airplanes. But manufacturers and consumers do not have perfect knowledge of these factors. They have no wav of knowing in advance exactly how many airplanes are going to be needed, and there are lead times involved in the production and purchase of airplanes. Manufacturers don't care if the airplanes they produce go for replacement or expansion of the stock. Their concern is with the total number of airplanes that can be sold. They have plant, labor, and material commitments to produce a specific number of airplanes. They cannot easily add or drop plant space; there are high costs (both direct and indirect) associated with hiring or laying off employees; and many material and parts commitments must be contracted far in advance. Because of the cost of adjusting the production rate, manufacturers cannot make changes every time there appears to be a minor fluctuation in demand. They generally wait until they are sure that there has been a real shift in demand. Consequently, manufacturers provide some of the inertia to the supply of new airplanes.

On the demand side, the dealers and consumers who purchase airplanes do so on the basis of their past experiences and expectations. (Dealers are considered to be on the demand side because airplane sales are counted when the airplane leaves the manufacturer.) Dealers develop habit patterns and have contractual agreements which force them to accept a certain number of airplanes. They may be unwilling to let dealerships go just because of a dip in demand.

The final consumers are also a factor. People get in the habit of flying airplanes of a certain age. If there are few new airplanes available, they will become accustomed to older airplanes and may be reluctant to pay a premium price to fly a newer model. Likewise, if they have become accustomed to the quality, feel, and low maintenance requirements of a new airplane, they may be reluctant to give these up. These consumer habit patterns tend to add inertia to the flow of new airplanes.

To summarize, the basic demand for airplanes is a demand for a stock of airplanes derived from a demand for a specific number of hours of flight time at a given rate of airplane utilization. The number of new airplanes demanded is the consumers' estimate of how many are needed for replacement and expansion. This estimate may not be accurate all the time due to habit patterns and contractual agreements. Manufacturers try to estimate future demand and gear production to the appropriate level. They may be slow to change this level of supply due to the expense of change unless they are sure demand has shifted.

A BASIC MODEL

The ideas from the previous section are combined in a simple model which expresses the fundamental factors involved in the new airplane sales cycle (Eq. 1). In this model, lower case letters are used to represent flows, such as sales of airplanes, and capital letters are used to represent stocks, such as the total stock of airplanes.

$$a_t = a^*_t + \delta(A^*_t - A_t) \qquad (1)$$

Where:

- a = sales of airplanes
- a* = the "nominal" level of sales
- A* = the ideal size of the stock in new airplane equivalents
- A = the actual size of the stock in new airplane equivalents
- t = time period
- δ = an adjustment weight between 0 and 1

The nominal sales level, "a*", is an expected sales level due to the inertia of past sales. It is the level that would occur if there were no additional stimulus from the stock being off its ideal size. It is the level of sales which would occur based on past trends, contractual agreements, and habit patterns.

The desired stock, "A*" is the size of the stock which consumers would want if airplanes were available at their long run cost, and if there were perfect knowledge of the amount of flying that was to be done. It is the long run target value which would eventually be achieved if the amount of flying stayed at the same level for a number of time periods.

The actual stock,"A", is the number of airplanes, in new airplane equivalents which are currently available for consumer use. The stock adjustment factor, "δ," indicates how important the difference between the desired and actual stock is. If consumers are intolerant of having to change utilization of the existing stock, and have a firm commitment to their desire for services, then the stock adjustment factor will tend to be high. In these cases differences between the desired and actual stocks will have a strong impact on sales.

Looked at as a whole, the model asserts that

the actual sales in time period "t" is a function of the nominal level of sales for that period, which represents the inertia of past sales, plus an adjustment which is proportional to the size of the difference between the ideal desired stock and the actual stock. The greater this difference, the stronger is the manufacturers' incentive to expand production and the greater the consumers desire to buy. Of course, if the actual stock is larger than the desired stock, this factor will have a negative influence and cause sales during the period to shift below the nominal level.

This model may be used to provide a picture of what happened during the 1971 to 1982 sales cycle. Sales were at a low in 1971 due to a number of economic reasons including a recession and credit restrictions. Many airplane dealers failed during this period and a large portion of the production work force was laid off. These factors caused sales to be low during 1970-71, and once sales slowed down there was a fair amount of inertia to overcome to increase the flow of airplanes to their previous rate. When the economy started to expand strongly in 1972 and 1973, it caused an expansion in flight activity and an increase in the size of the desired stock of airplanes. As the desired stock became larger than the actual stock, there was a positive force to increase the flow of new airplanes. Due to the inertia of the past low sales levels the increase was not adequate to bring the actual stock up to the size of the desired stock.

Entering the fuel crisis and recession in 1974-75, the desired stock was still larger than the actual stock, but these two factors worked together to drop the desired stock back to about the size of the existing stock. This removed the force that had been expanding new airplane sales, but because the actual stock was now close to its ideal size there was no negative influence to cut down on sales. The inertia of the flow of new airplanes (contractual agreements, habits, etc.) kept sales at close to a constant level. Before this flow of new airplanes caused the actual stock of airplanes to become excessively large, the economy again began to expand. Therefore, the size of the desired stock increased and a positive force was exerted to increase sales. It should be remembered at this point that it requires only a moderate increase in the size of the desired stock to increase greatly the quantity of new airplanes needed.

In the late 1970's, the high level of sales caused the actual stock to catch up to the desired stock. Due to the inertia of the high sales level, the actual stock became larger than the desired stock. This alone would have cause a decline in sales but it was aggravated by a number of factors. At this same time interest rates and fuel prices rose sharply and in 1980 the economy entered a recession. All of these factors caused the size of the desired stock to shrink and thus created a large negative gap between the desired and actual stock. This gap exerted strong downward pressure on sales in 1980 and 1981. Since airplanes depreciate at a relatively low rate and since the sales inertia continues to cause some new airplanes to flow into the stock, it takes a long time for the actual stock to drop down to the size of the desired stock. Sales have now been at a low level for a number of periods, and until the desired stock becomes considerably larger than the actual stock there will not be a strong pressure to increase sales.

STATISTICAL ESTIMATION OF THE MODEL

Although this model provides a very plausible explanation of how the sales cycle operates and may be quite useful for discussing the cycle, it is desirable to test it using actual data. However, this is not possible with the model in its present form because the nominal level of sales and the desired stock are not directly observable. Therefore, it is necessary to substitute proxy variables into the model which represent the approximate level of these variables.

It was decided the nominal sales could be represented using an exponentially smoothed series of past sales computed as shown in Equation 2.

$$a_t^* = \alpha a_{t-1} + (1-\alpha) a_{t-1}^* \quad \text{where } 0 < \alpha < 1 \qquad (2)$$

It is assumed that high levels of sales in the recent past would cause the value of this variable to increase, but that knowledge of past cyclical swings would cause some degree of conservatism in estimates of future sales levels. Where it is anticipated that there is a strong trend in the past sales along with the cyclical swings, a double exponentially smoothed series of past sales can be used to pick up this anticipated trend.

The desired stock was assumed to be a linear function of income (y_t) and prices (p_t) so that:

$$A_t^* = \gamma^0 + \gamma^1 y_t - \gamma^2 p_t \qquad (3)$$

This simply states that as income goes up the hours flown increases and thus the desired stock will also increase. As the price of flying goes up the demand will tend to decline.

Substituting Equation (3) into Equation (1) and expanding:

$$a_t = a_t^* + \delta \gamma^0 + \delta \gamma^1 y_t - \delta \hat{\gamma} p_t - \delta A_t \qquad (4)$$

This equation can now be estimated using ordinary least squares estimation techniques.

Because the demand characteristics for different classes of GA airplanes may vary, the airplanes were grouped into reasonably homogeneous classes. The following are the results of estimating the model with data on domestic sales of basic single engine (BSE) airplanes. These airplanes have fixed landing gear, a fixed pitch propeller, and less than 200 horsepower. Disposable personal income in constant dollars was used as the income variable. Fuel prices in constant dollars were used as the price variable. The stock was weighted to reflect productive capacity in terms of new airplane equivalents, and 0.7 was used as the smoothing constant in computing the nominal sales series. Dummy variables were used to correct for the abnormally high sales in 1966 caused primarily by the Cessna 150 marketing program, and the depressed sales in 1970 caused by the lack of availability of credit.

Estimating this model using data for various periods brings out both strengths and weaknesses. It was estimated using 19 years of data from 1960 to 1978, and using 21 years of data from 1960 to 1980. In both cases the results are quite reasonable and the coefficients of the income, stock, and nominal sales variables had the correct sign and were statistically significant. Figure 2 depicts how close actual sales were to the levels predicted by the model for BSE airplanes.

When the model is estimated with data from 1960 to 1978 and forecasts are made using the actual levels of all exogenous variables, the results are poor. One reason for this poor performance is the lack of any price variable in the model estimated with 1960 to 1978 data. Numerous price variables were tested, including interest rates, a fuel price index, and an airplane price index. None proved to be statistically significant. However, this is not surprising considering what happened to prices in real terms during this period. By referring to Figure 3, it can be seen that up through 1978 there were only minor variations in the real prices of fuel and airplanes, and that interest rates were not out of line. With this lack of significant price variation prior to 1978, it is impossible for the model to estimate what the impact of price variations would be. Thus when there were sharp increases in interest rates, the price of fuel, and the price of airplanes, it is not surprising to find that actual sales were below those forecasts by the model. When data for 1979 and 1980 are included in estimating the model, the coefficient of the price variable becomes significant and the model performs much better in the 1978 to 1981 time period. Although all prices increased during this period, extensive statistical tests suggested that fuel prices were the most significant. Attempts to construct a price variable composed of a weighted average of the factor costs were not successful.

However, even with the improvement in the model's performance, it does a poor job of estimating the sales levels for 1982. There are several possible explanations for this. First, there are little data on the effect of price increases on the demand for flight hours. Only a fuel price variable proved to be statistically significant in the model, but interest rates and the price of new airplanes must also have had an impact.

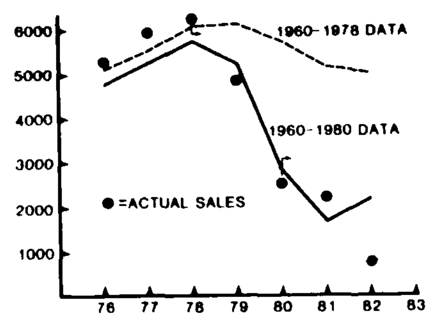
Of particular importance may be the price of new airplanes which, in real terms, has increased significantly only during the past two years. As airplane prices increase, there is an increase in the overall cost of flying, but possibly more importantly, there may be a shift toward higher utilization of airplanes. Aircraft operators will try to offset the increase in price by utilizing their equipment more intensively. This means that a smaller stock of airplanes is needed to produce a given number of hours of flight time.

At the present time a decrease in the size of the desired stock means that the gap between the desired and actual stock will continue to be negative or possibly positive but of small magnitude. Without this pressure to expand sales, the inertia of the current low level of sales will continue until the actual stock has shrunk through depreciation to a level considerably below the desired stock.

Another important consideration during the current time period is that the industry is not operating under "normal" conditions. It may be asking too much of a linear model estimated with data from more normal times to predict what will happen in the extreme case we are now experiencing.

FIGURE 2

BASIC SINGLE ENGINE MODEL PERFORMANCE

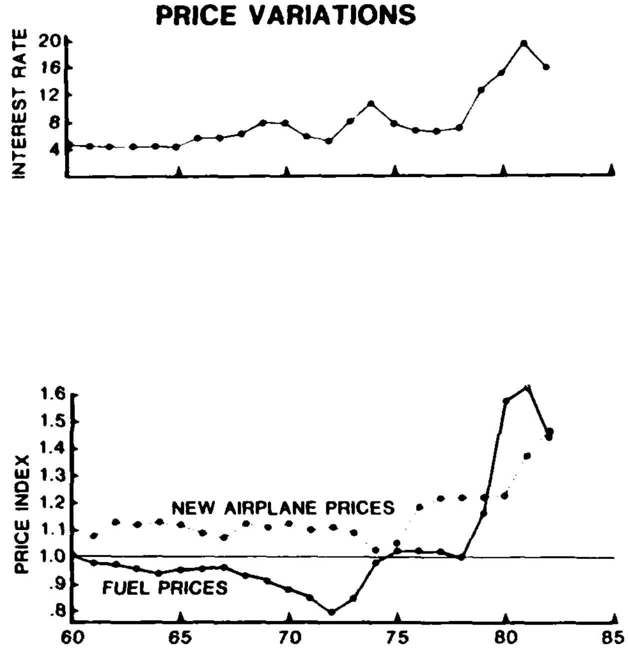


However, the above limitations do not negate the value of the underlying model of how the industry operates. Instead they represent problems of properly specifying each component of the model. The model provides a foundation which can be used to help understand the industry. It can be used to keep us focused on the basic factors involved in growth of general aviation. It can help us to understand the cycle, to understand that the strong upswings which occurred during the 1970's cannot be

sustained indefinitely. It can also help us to understand that a normal cyclical downswing, if coupled with a recession such as the one we are in now, will produce a severe drop in new airplane sales; but that this does not mean the industry is doomed. The inertia of low sales may linger longer than we like, but a positive gap between desired stock of airplanes and the actual stock will again develop and bring with it the strong cyclical upswing we have seen in the past.

FIGURE 3

PRICE VARIATIONS



DR. SCHWARTZ: Our next participant is Rosalyn Shirack. Rosalyn is currently a transportation economist with the Oregon Department of Transportation. She has worked primarily with the Oregon Aviation System Plan and the Aircraft Activity Counter Demonstration Project. Rosalyn is also responsible for economic and financial planning for highways, rail and public transit and policy development. Prior to her position with the Oregon Department of Transportation, Rosalyn was a policy and research analyst for the Oregon Department of Land Conservation and Development from 1978 to 1982. Her work there included land use policy development, legislative and fiscal analysis and legal review of land use cases. Rosalyn received her B.A. in Political Science from Wichita State University, Wichita, Kansas. She also has an M.S. in Agricultural and Resource Economics from Oregon State University. I would like to present Rosalyn Shirack.

USE OF SAMPLE DATA FOR ESTIMATING AIRCRAFT ACTIVITY AT NON-TOWERED AIRPORTS

Rosalyn Shirack

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SUMMARY

Ms. Shirack and Mr. Ford present the results of the Aircraft & Activity Counter Demonstration Project and analyze the implications of the data obtained. At various non-towered airports in the Pacific Northwest region, RENS Aircraft Activity Counters recorded the sounds of departing aircraft for sample time periods. Later auditing of the tapes enabled them to monitor aviation activity at those airports. Statistical analysis led to extrapolation of yearly and seasonal totals. Ms. Shirack and Mr. Ford conclude that RENS Counters provide a good estimate of activity at non-towered airports, avoiding both the expense of the visual observation method and the inaccuracy of the non-towered/nearby towered airport method.

ACKNOWLEDGEMENT

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INTRODUCTION

Insufficient knowledge of activity at non-towered airports has been a concern of state and federal aviation agencies as well as local airport sponsors. Until recently, there was no accurate alternative to visual observations for

determining aircraft activity. This means that where there is no tower, estimates of operations often amount to a virtual guess. This is especially true of small general aviation facilities which often are without full-time managers or fixed base operators.

Many methods of determining operations at non-towered airports have been tried throughout the country. These range from visual surveys to use of permanent highway counters. Many of the most popular methods, including those approved by the FAA, of estimating operations require visual surveys during a sample period and use of statistics from towered airports to estimate operations over a full year. It is widely recognized that the results of these endeavors have been far from satisfactory. The accuracy of non-visual survey methods has always been dubious and the procedures for expanding sample counts to annual estimates had, until recently, never been adequately tested.

In 1977 the RENS Manufacturing Company, in cooperation with the Oregon Aeronautics Division, began testing a prototype acoustical aircraft activity counter. Between July 1978 and September 1979, the RENS Aircraft Activity Counter was tested by the Oregon Aeronautics Division under a contract with the Federal Aviation Administration.

A subsequent project using the RENS counter, the Aircraft Activity Counter Demonstration Project, was carried out by the States of Oregon, Washington and Idaho. The project was funded by the Federal Aviation Administration, the Pacific Northwest Regional Commission, and the three states.

The objectives of the Aircraft Activity Counter Demonstration Project were:

1. To obtain, on a demonstration basis, accurate aircraft operation statistics at selected airports in order to determine actual usage of these facilities, and

2. To develop statistical procedures for obtaining accurate operation statistics using a limited sample count by the RENS Aircraft Activity Counter.

Data were gathered at 37 non-towered airports throughout three northwest states. The results of the project are contained in the project's Final Report, 1982, available from the Oregon Aeronautics Division.

The primary purpose of this paper is not to discuss the project or the use of the RENS Counter per se, but to investigate the implications of data obtained through the project. Section II of the paper describes the Aircraft Activity Counter Demonstration Project, which is the source of data used in this paper. Section III discusses the use of independent data including operations data at towered airports, weather data, and fuel sales data, to estimate annual operations at non-towered airports. Section IV of the paper presents a sampling plan for estimating aircraft activity at non-towered airports without relying on independent estimates of seasonal variation. Section V discusses how sample counts are used to estimate annual operations and to determine the precision of the estimate. The distribution of operations, including daily and hourly peaks, is also discussed. The final section summarizes the major conclusions of the analysis.

THE AIRCRAFT ACTIVITY COUNTER DEMONSTRATION PROJECT

From November, 1980 through April, 1982, RENS Aircraft Activity Counters were used to gather operations data at 37 airports in Oregon, Washington and Idaho. The RENS counter records the sound of departing aircraft on cassette tapes which are then "audited"; activity is classified by time and date. The sounds of departing aircraft can often be classified into several aircraft types, but results of the counter project indicate the most reliable data are based on total fixed-wing departures.

Generally, a single counter was used to make periodic counts at several airports throughout a one-year period. In three cases, a counter remained permanently at an airport for periods up to one year. A summary of the counting periods for the airports studied is shown in Table I.

Volunteer weather observers at each airport recorded weather conditions during counting periods for use in assessing the impact of weather on airport activity. Operations and weather data were compiled in computer files for use in subsequent analysis.

Statistical analysis of the data was made by Oregon State University, Survey Research Center. Estimates of total annual fixed wing operations were made for 29 of the 37 airports sampled. Data for eight of the airports did not contain counts in all seasons and, therefore, were insufficient to allow unbiased estimation of annual totals.

In addition to providing operations estimates at 29 airports, the study also provided a valuable data base for further analysis of operations at non-towered airports. Because data were gathered throughout a full year for each airport, knowledge of seasonal variation in activity at non-towered airports was significantly improved. It has become possible to test some of the assumptions inherent in the use of independent data in estimating annual operations, as discussed in Section III. The project data also provides valuable information for designing sample procedures when accurate independent estimates of seasonal variation are not available.

TABLE 1

DATES OF AIRCRAFT ACTIVITY COUNTS
BY AIRPORT

Airport	Date Count Started*	Date Count Ended*	Days Counted*	Number of Count Periods	Days In Shortest Count*	Days In Longest Count*
OREGON						
Albany	12/11/80	11/25/81	58	11	3	8
Arlington	2/25/81	3/27/82	102	12	5	17
Ashland	2/06/81	2/25/82	102	13	7	8
Beaver Marsh State	3/18/81	1/15/82	70	10	1	15
Christmas Valley	2/25/81	12/22/81	123	11	7	17
Creswell	11/26/80	10/04/81	82	11	6	9
Grants Pass	1/23/81	12/31/81	97	14	2	9
Hermiston	4/24/81	4/24/82	109	11	7	20
Hood River	2/04/81	1/19/82	122	13	5	15
LaGrande	5/29/81	4/30/82	101	8	5	32
Lebanon State	12/04/80	1/05/82	115	11	7	26
McMinnville	11/20/80	10/25/81	76	12	2	8
Medford	1/30/81	12/11/81	78	11	3	8
Newport	1/22/81	12/27/81	83	13	2	10
Pinehurst State	3/13/81	3/04/82	102	12	6	12
Seaside State	4/01/82	3/29/82	155	13	5	29
Siletz Bay State	2/26/81	1/03/82	80	11	6	9
Sunriver	2/12/81	1/11/82	130	12	5	20
Tillamook	1/08/81	10/21/81	70	9	7	8
Wasco State	2/19/81	3/05/82	81	11	2	10
WASHINGTON						
Bellingham	1/14/81	10/09/81	55	6	4	18
Bremerton	1/07/81	8/19/81	49	6	5	10
Chehalis	2/13/81	11/03/81	43	4	8	14
Ellensburg	3/01/81	10/24/81	49	5	6	16
Ephrata	2/03/81	11/05/81	37	4	7	13
Hoquium	3/02/81	1/17/82	66	4	11	21
Kelso	12/15/80	9/25/81	30	6	3	8
Omak	3/01/81	10/19/81	55	7	4	11
Port Angeles	2/02/81	1/28/82	73	7	5	14
Pullman	3/17/81	9/24/81	44	6	1	12
Puyallup	1/16/81	12/23/81	32	4	5	10
Richland	5/06/81	4/22/82	89	6	3	30
Skagit	1/27/81	12/10/81	56	7	4	15
Wenatchee	1/22/81	12/14/81	62	7	5	20
IDAHO						
Coeur D'Alene	5/01/81	11/03/81	154	8	4	47
Hailey	4/09/81	4/07/82	302	7	15	70
McCall	4/21/81	8/22/81	93	6	8	25

*May include partial days, i.e., less than 24-hour days.

USE OF INDEPENDENT DATA TO ESTIMATE OPERATIONS AT NON-TOWERED AIRPORTS

Independent data have been used historically to estimate annual operations at non-towered airports due to the high cost of obtaining complete visual counts of operations. Independent data are often used in conjunction with a limited sample of observed operations to estimate annual operations. The underlying assumption in the use of independent data is that they measure the variation in operations throughout the year. Measures of variation are used to expand the limited sample operations into an estimate of annual operations. Estimates of operations based on independent data have always been suspect, but there has been no means for testing the degree of error in such estimates.

Operations data obtained through the Aircraft Activity Counter Demonstration Project were gathered throughout a full year at each of the study airports. As a result, the data provide information on the seasonal variation of operations. These data were used to test the accuracy of independent data sources as measures of variation of operations at non-towered airports. Independent data sources analyzed included tower operations data, weather data, and fuel sales data. As tower operations data are widely used and readily available, they were studied in depth. A preliminary study of *weather data and fuel sales data* is also reported.

Use of Tower Operations Data to Estimate Non-Tower Operations

Airport operations data at towered airports are currently used to estimate operations at non-towered airports. The FAA publication, Statistical Methods for Measuring Aeronautical Activity at Non-Towered Airports, [1] identifies five methods for estimating operations. These methods rely, in part, on operations data from towered airports. Tower data are used to adjust non-tower operations data obtained from a small (7 to 21 day) sample. There are several different estimating equations, but all are based on the ratio relationship:

$$\frac{\bar{y}}{\bar{Y}} = \frac{\bar{x}}{\bar{X}} \quad \text{, where} \qquad (1)$$

$\bar{y}$ = average daily non-tower operations during the sample period.

$\bar{Y}$ = average daily non-tower operations during the year.

$\bar{x}$ = average daily tower operations during the year.

$\bar{X}$ = average daily tower operations during the year.

The use of tower operations data to estimate non-tower operations is based on the assumption that:

1. Towered and non-towered airports can be paired according to similarities in mix of operations, weather, and daily traffic variation, and

2. Paired towered and non-towered airports will have a similar distribution of operations.

If these assumptions are not met, there is no reason to believe that tower operations data are applicable to non-tower surveys. The FAA publication recognizes the question of applicability, but continues to recommend the use of tower data in the absence of accurate data from non-towered airports. Data gathered during the Aircraft Activity Counter Demonstration Project were used to test these two assumptions.

Method of Comparing Towered and Non-Towered Airports

Estimates of annual operations by quarters at 23 non-towered airports were compared to quarterly operations data for the closest towered airport. The Medford Airport was used as a control since both tower operations data and counter sampled operations data were available. Tower operations data were obtained from the 1978 Tower Airport Statistics Handbook. [2] A total of nine towered airports in Washington and Oregon were used in the study. Over 95 percent of the sampled non-towered operations were general aviation operations. Therefore, only itinerant and local general aviation data for towered airports were used in order to be comparable to the type of operations observed at non-towered airports.

The quarterly distribution of operations at towered and non-towered airports are considered similar if they do not differ by more than 25 percent in any one quarter. A 25 percent difference was allowed because: (1) it provided for a liberal, but reasonable, tolerance of variation, and (2) sampled operations at Medford Airport differed by as much as 25 percent from the published tower data for the same airport during a single quarter. [3]

Result of Comparison of Operations

The comparison of the quarterly distributions of operations at non-towered and nearby towered airports yielded few similar pairs (see Table 2). Of the 23 paired towered and non-towered airports studied, only four (17 percent) had similar (within 25 percent) distributions of operations. All four were pairs involving the Salem Airport. The other 19 tower/non-tower pairs were not similar due to the wide

Table 2: Distributions across Quarters of Operations at Tower Airports and of Estimated Operations at Selected Airports

State	Closest Tower Airport	IFR/ NO IFR	Airport	Percent of Annual Operations QTR 1	QTR 2	QTR 3	QTR 4
OR	Salem			19%	31%	30%	20%
		IFR	McMinnville	31	18	30	21
			Newport	19	27	33	21
		NO IFR	Albany	22	29	32	17
			Creswell	18	31	34	17
			Lebanon State	19	35	32	15
			Siletz Bay State	9	36	36	19
	Hillsboro			21%	28%	31%	20%
		NO IFR	Tillamook	22	21	20	37
			Seaside State	9	34	43	15
	Troutdale			21%	31%	29%	19%
		NO IFR	Hood River	12	27	45	16
	Pendleton			26%	31%	27%	16%
		IFR	Hermiston	20	30	28	22
			La Grande	10	26	52	12
			Wasco State	61	14	14	10
			Arlington	36	50	7	7
	Klamath Falls			21%	26%	33%	20%
		NO IFR	Sunriver	12	27	49	12
			Christmas Valley	23	25	38	14
			Beaver Marsh State	9	48	30	14
	Medford			20%	31%	31%	18%
		IFR	Medford	17	39	30	14
		NO IFR	Grants Pass	35	30	28	7
			Ashland	26	27	34	13
			Pinehurst State	15	29	48	8
WA	Sea-Tac			19%	28%	33%	20%
		IFR	Hoquiam	18	32	15	35
	Moses Lake			27%	29%	21%	23%
		IFR	Wenatchee	22	29	27	22
			Omak	29	24	28	18
	Portland, OR			26%	27%	26%	21%
		IFR	Kelso	33	27	13	28

SOURCE: Aircraft Activity Counter Demonstration Project Final Report.

fluctuation in the quarterly distribution of operations at non-towered airports.

Among non-towered airports, the proportion of annual operations that occurred in a single quarter ranged from a low of 7 percent to a high of 61 percent. Furthermore, there was no consistent pattern among non-towered airports of the distribution of operations across quarters. With few exceptions, each non-towered airport exhibited a unique distribution of quarterly operations.

By comparison, the distributions of operations among towered airports were much more uniform. The proportion of annual operations that occurred in a single quarter ranged from a low of 16 percent to a high of 33 percent. Unlike non-towered airports, there was a consistent pattern in the distribution of operations across quarters. Generally, the first and fourth quarters each claimed about 20 percent of annual operations, while the second and third quarters each had about 30 percent of annual operations.

Conclusion

This comparison indicates that the two assumptions necessary to support the use of tower operations data to estimate non-tower operations are not justified. The distribution of operations at towered airports are not sufficiently similar to paired non-towered airports for estimating purposes. Therefore, tower operations data should not be expected to provide reliable estimates of operations at non-towered airports.

An example using LaGrande non-towered airport illustrates how a serious over-estimation of operations at LaGrande could result from using Pendleton tower operations data. LaGrande Airport is about 45 miles from Pendleton Airport. The two airports share the same weather and, therefore, flying conditions. LaGrande has an instrument approach and 5,940 operations a year, which is about 12 percent of the level of general aviation activity at Pendleton Airport. The two airports appear to be a good non-tower/tower pair for the purposes of estimating non-tower operations. However, the quarterly distribution of operations at the two airports is not similar. If general aviation operations data from Pendleton Airport were used to expand sample data drawn during the third quarter at LaGrande Airport, annual operations would be estimated to be 10,107:

$$MCE = N\bar{y} + Y'\left(1 - \frac{\bar{x}}{\bar{X}}\right) \qquad (2)$$

$$= (365)(33.6) + 30{,}000\left(1 - \frac{143.72}{134.17}\right)$$

$$= 10{,}107$$, where

MCE = minimum change estimate.[4]

N = number of days in the year of the survey.

$\bar{y}$ = average daily operations at LaGrande during the third quarter sample period.[5]

Y' = estimate of annual operations at LaGrande made prior to the survey.[6]

$\bar{x}$ = average daily operations at Pendleton during the third quarter sample period.

$\bar{X}$ = average daily operations at Pendleton during the year that includes the sample period.

The estimate of 10,107 annual operations at LaGrande based on Pendleton operations data is 70 percent higher than the 5,940 estimate of annual operations based on a more complete sampling of actual activity at LaGrande. This result is due to the fact that the proportion of annual operations that occur in the third quarter at LaGrande and Pendleton Airports are not the same, as was assumed. Fifty-two percent of annual operations at LaGrande occur in the third quarter, compared to only 27 percent at Pendleton (Table 2). The 93 percent difference in the proportion of this quarter operations would result in a 93 percent over-estimate of annual operations at LaGrande if the simpler ratio equation (Equation (1)) were used.

The conclusion that the variation in tower and non-tower operations is not sufficiently similar for estimating purposes is expected to hold even if non-towered airports were paired with different towered airports. Given the similarity in the quarterly distribution of operations among all towered airports, it is not likely that a "better" pairing of towered and non-towered airports in this study would have improved the estimating capability of tower operations data. For example, LaGrande Airport is not only dissimilar to Pendleton Airport, but is also dissimilar to all of the other towered airports in the study.

The dissimilarity in paired towered and non-towered airport operations may be due to different characteristics of users. Even when air carrier and commuter operations are eliminated from the statistics, towered airports tend to have a much larger volume of operations and a wider variety of users. At non-towered airports, it is likely that a large portion of operations results from specialized activities. At the Wasco State Airport, for example, 61 percent of annual operations occurred in the first quarter because of local crop spraying schedules.

In addition, the general aviation activity at towered airports is less sensitive to weather conditions. This is due, in part, to the presence of business aircraft, which are less sensitive to flying conditions. Training and recreational flying, which are more sensitive to weather conditions, tend to account for a larger percentage of operations at non-towered airports. The majority of non-towered airports do not have instrument approaches.

Use of Weather Data to Estimate Non-Towered Operations

During the Aircraft Activity Counter Demonstration Project weather data were gathered for most of the days on which aircraft departures were sampled. These data indicate that there is a high correlation between weather conditions and departures. Departures were generally higher in the second and third quarters (April through September), when flying conditions tended to be better, than in the fourth and first quarters (October through March). Furthermore, departures varied with weather conditions within each quarter.

It was not possible to use weather as a component of variance in estimating annual operations during the project. Weather data were not available for each day on which departures were counted or for the remaining days of the year. Daily weather data collected at regional weather stations were costly to acquire in a usable form and did not necessarily reflect weather conditions at the sample non-towered airports. If daily weather data for a sampled airport were available, they would be expected to help provide an estimate of the seasonal variation in operations. The size of the sample of departures could be greatly reduced, because the weather data would account for much of the seasonal variation believed to affect operations. However, other components of variation, such as type of day (weekday or weekend/holidays) and non-weather seasonal variation, would still have to be captured directly by sampling departures.

Use of Fuel Sales Data to Estimate Non-Towered Operations

Another possible independent data source reviewed was fuel sales data. The data consist of gallons of aviation gasoline pumped into aircraft. In Oregon the data are reported monthly by most airports that sell fuel.

A preliminary analysis of the relationship between monthly fuel sales data and estimated departures at eight non-towered airports was conducted. The analysis was limited to the number of months that were adequately sampled and to airports with accurate fuel sales data. The correlation coefficient of gallons of fuel sold and number of departures was between 92 and 97 percent at six of the eight airports. The other two airports had coefficients of about 68 percent.

This initial review indicates that fuel sales data may provide a good measure of monthly and seasonal variation of operations. Further study is necessary before these data can accurately be incorporated into estimating procedures.

SAMPLING DESIGN FOR NON-TOWERED AIRPORTS

Use of Systematic Cluster Samples

When there is no accurate independent indicator of seasonal variation at a particular non-towered airport, or in cases where the indicators themselves must be tested for reliability, it will be necessary to conduct samples of activity throughout the year.

If cost were not a constraint, the most accurate plan would call for either a random sample of days throughout the year, or a full year count. To generate the necessary size sample by a random procedure using the RENS Counter would cost more than leaving the counter in place and taking a full year count. The solution posed here is to sample clusters of seven days systematically throughout the year. All departures occurring during each of the sampled seven-day periods would be counted using the RENS Counter.

Analysis of data obtained in the Aircraft Activity Counter Demonstration Project indicates that significant differences in airport activity are associated with day of the week and season of the year. In order to sample where the variation occurs, days should be stratified into weekdays and weekends and holidays. Seasons should be stratified based on annual weather patterns. For most areas of the country two, three, or four seasons could be used. If four seasons are used, the sample would be stratified into eight separate cells. If seven-day clusters are used, then a stratified sample is automatically proportional with respect to the day of the week. A systematic sample of seven-day clusters, which provides for an equal number of evenly spaced clusters per season, will provide proportionality with respect to seasons.

If seasonal as well as annual estimates of operations are desired, it is necessary to sample at least two seven-day clusters in each season. Since seven clustered days are sampled instead of seven random days, the variance within the clustered days may not represent the variance in the total population. Given the potential for unusual weather patterns or other factors which could bias the data gathered during a single week within a season, it is advisable to sample at least two seven-day clusters in each season, even if seasonal estimates are not desired.

To ensure randomness in the sample, the first of the sample weeks is randomly chosen. The following weeks are systematically sampled at equal intervals throughout the season. For instance, if two weeks in a 13 week season are to be counted, they should be spaced six weeks apart. If the random selection process chooses week three for the first count, then week nine must be selected for the second count.

The sample size may be chosen to reflect the desired trade-off between cost and accuracy. Preliminary estimates of sampling error for

TABLE 3

APPROXIMATE PERCENT SAMPLING ERROR IN ANNUAL ESTIMATE
AT 95% CONFIDENCE LEVEL
BY SIZE OF AIRPORT AND SIZE OF SAMPLE

Approximate Annual Operations at Airport Being Sampled	Number of Weeks Sampled Per Year: 4	6	8	10	12
< 900	± 54%	± 44%	± 37%	± 32%	± 29%
900 - 2,399	51	41	34	30	27
2,400 - 4,399	47	38	32	28	25
4,400 - 7,199	44	35	30	26	23
7,200 - 10,499	40	32	27	24	21
10,500 - 14,599	36	29	25	21	19
14,600 - 19,199	33	26	22	19	17
19,200 - 24,599	29	23	20	17	15
24,600 - 30,499	25	20	17	15	13
≥ 30,500	22	17	15	13	12

alternative sample sizes and expected numbers of annual operations are shown in Table 3. Development of the table is discussed in the Appendix.

The estimated sampling errors are generally conservative. They do not reflect the increased precision expected from a stratified sample. On the other hand, the variation of an estimate based on a cluster sample rather than a simple random sample may be higher than those reflected in Table 3.

In order to divide the year into seasons to take full advantage of seasonal stratification, an analysis was made of the average percentage of annual operations occurring in each month. Months were grouped to minimize the variation in average percentage of annual operations within each season while requiring equal length seasons. Months were grouped into four, three, and two seasons. Obviously, the result applies only to the Pacific Northwest. However, similar patterns probably exist in most regions of the continental United States and Canada.

Seasonal Stratification	Months in Each Season
4 Seasons	January - March
	April - June
	July - September
	October - December
3 Seasons	October - January
	February - May
	June - September
2 Seasons	October - March
	April - September

Sampling Cost

One of the most significant aspects of the acoustical aircraft activity counter is that it permits periodic sampling or continuous monitoring at non-towered airports at a reasonable cost. The RENS counter costs about

\$2,500 per unit to purchase and has very low annual maintenance costs. If the counter is left at an airport to monitor activity continuously the largest cost would be for tape audits. Audits tend to run \$.50 to \$1.00 per minute of recorded tape. Depending on the number of recorded departures per minute of tape, and assuming minimal audit costs per tape, total audit costs would be between \$400 per year for an airport with less than 5,000 annual operations to \$2,500 per year for an airport with 50,000 operations. Total cost of counts based on continuous monitoring would range from \$1,600 to \$3,700 per airport.

Sampling with an acoustical counter will normally provide a cost effective option to continuous monitoring or visual counts. When a single counter is rotated among several airports the most expensive part of the sampling process will be the cost of moving the counter. When these costs reach \$700 to \$1,000 for an airport, it will again become more cost effective to leave the counter at the airport, assuming that an operator can be found in the area. Even when the counter is left at an airport, it may be appropriate to use it only for periodic samples in order to reduce tape audit costs. In addition to tape audit and counter moving costs, analysis of each airport will also require data processing, supplies, professional analysis, and depreciation on the counter.

The cost of resampling the Oregon airports previously counted as part of the Aircraft Activity Counter Demonstration Project were recalculated based on the sampling plan presented in this paper and cost factors relevant to Oregon. Assuming a sample size to keep the sampling error in the range of 20 percent, costs range from \$1,000 to \$2,000 per airport. Costs would be higher if a larger sample were desired in order to reduce the sampling error. Costs could be lowered by tolerating less accurate estimates.

ESTIMATING ANNUAL OPERATIONS & THE DISTRIBUTION OF OPERATIONS FROM SAMPLE DATA

After the sampling of departures has been concluded, the sample data must be expanded to a full year estimate of operations. This section illustrates how annual operations and sampling error are estimated from data gathered according to the plan in the previous section. Specifically, this estimating procedure assumes sample data that consist of counts of departures taken during two seven-day periods in each quarter of the year. The procedure could be modified for a two or three season stratification as well. Each sampled airport is estimated separately. The definition of terms is presented first, followed by the equations used to estimate annual operations at a sampled airport.

The definition of terms is as follows:

d_{ij}	=	number of departures counted during the i^{th} week in the j^{th} quarter
x_k	=	number of departures counted during each of the seven days of the i^{th} week
$\bar{d}_j$	=	estimated mean weekly departures in the j^{th} quarter
n	=	number of weeks sampled in the j^{th} quarter, in this case n=2
$\hat{D}_j$	=	total departures during the j^{th} quarter
$2D_j$	=	estimated total operations in the j^{th} quarter
$\hat{V}(2D_j)$	=	estimated variance of the estimated operations in the j^{th} quarter
$\hat{E}(2\hat{D}_j)$	=	estimated percent sampling error of the estimated operations in the j^{th} quarter
$2\hat{D}$	=	estimated total annual operations
$\hat{V}(2\hat{D})$	=	estimated variance of the estimated total annual operations
$\hat{E}(2\hat{D})$	=	estimated percent sampling error of the estimated total annual operations

The steps used to estimate annual operations at a sampled airport are as follows:

1. Determine the number of departure counted during the i^{th} week in the j^{th} quarter as

$$d_{ij} = \sum_{k=1}^{7} x_k \qquad (3)$$

2. Estimate mean weekly departures in in the j^{th} quarter as

$$\bar{d}_j = \sum_{i=1}^{n} d_{ij}/n \qquad (4)$$

3. Estimate total departures during the j^{th} quarter as

$$D_j = 13\,\bar{d}_j \qquad (5)$$

4. Estimate total operations in the j^{th} quarter as $2\hat{D}_j$

5. Estimate the variance of the estimated total operations in the j^{th} quarter as 7

$$\hat{V}(2\hat{D}_j) = (2^2)(13^2)(1-\frac{n}{13})$$

$$\bullet\left[n\sum_{i=1}^{n} d_{ij}^2 - (\sum_{i=1}^{n} d_{ij})^2\right] / n^2\ (n-1) \quad (6)$$

6. Estimate the percent sampling error of the estimated total operations in the j^{th} quarter at the 95 percent confidence level as

$$\hat{E}(2\hat{D}_j) = 100\left[\hat{V}(2\hat{D}_j)\right]^{1/2} / \hat{D}_j \quad (7)$$

7. Estimate the total annual operations as

$$2\hat{D} = \sum_{j=1}^{4} 2\hat{D}_j \quad (8)$$

8. Estimate the variance of the estimate total annual operations as

$$\hat{V}(2\hat{D}) = \sum_{j=1}^{4} V(2\hat{D}_j) \quad (9)$$

9. Estimate the percent sampling error of the estimated total annual operations at the 95 percent confidence level as

$$\hat{E}(2\hat{D}) = 100\ [\hat{V}(2\hat{D})]^{1/2} / \hat{D} \quad (10)$$

It should be emphasized that the above equations are applicable only for a sample that consists of two seven-day clusters chosen from each quarter of the year. For example, if departures during a full seven-day week are not counted and there is no way of accurately estimating departures for the missing day(s), then the above estimating equations must be modified. Instead of counting weekly departures and estimating mean weekly departures as in Steps 1 and 2, the days on which departures were counted should be post-stratified into weekday and weekend strata. Any holidays counted should be included in the weekend stratum. Daily departures and mean daily departures would then be determined independently for each of the two strata. Total departures for the quarter would be estimated as follows:

$$\hat{D}_j = (\bar{\bar{d}}_{wj})(M_{wj}) + (\bar{\bar{d}}_{wd\ j})(M_{wd\ j}), \quad (11)$$

where

$\hat{D}_j$ = estimated departures during the j^{th} quarter

$\bar{\bar{d}}_{wj}$ = mean daily departure during in the weekday stratum during the j^{th} quarter

M_{wj} = total number of days in the weekday stratum during the j^{th} quarter

$\bar{\bar{d}}_{wd\ j}$ = mean daily departures in the weekend/holiday stratum during the j^{th} quarter

$M_{wd\ j}$ = total number of days in the weekend/holiday stratum during the j^{th} quarter

Estimates of variance and sampling error would also be modified to account for the weekday and weekend/holiday strata.

Distribution of Operations

A representative sample of departures can provide information on the distribution of airport activity as well as estimates of total and mean operations. The empirical or observed distribution of sample data can be considered the most likely distribution of the population in the absence of other information about the population distribution. 8/

Often the distribution of operations, including peak operations, is as important to airport planning, funding, and management decisions as is the *estimate of operations*. For example, an estimate of peak daily operations is needed to plan for airport design capacity, airport improvement project, and service demands.

Quarterly and Monthly Distributions

Calculations of quarterly distributions of operations or peak monthly operations are often desirable for planning purposes. Quarterly distribution may be determined by dividing the quarterly estimates by the annual estimates. Independent information, such as weather or fuel sales data, may be useful in making estimates of quarterly, or even monthly, variation using smaller samples. Likewise, independent information would be required to estimate peak month operations accurately. More research is required, however, in the collection and use of such independent data.

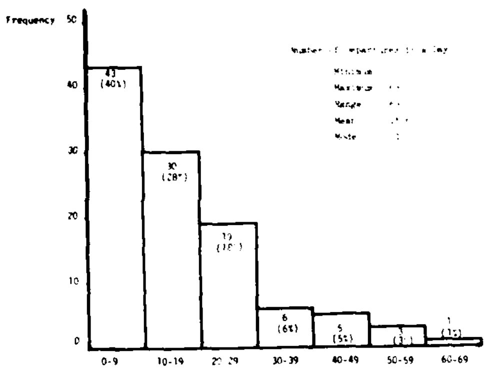
Daily and Hourly Distributions

Use of the proposed sampling procedures will give estimates of peak daily departures for planning purposes. Since daily operations are expected to be twice the number of daily departures (assuming an equal number of arrivals and departures), the distribution of daily operations should mirror the distribution of daily departures. The sampling procedure will also give a useful indication of hourly peaks in terms of departures, but does not measure hourly

operations. The distribution of hourly operations cannot be inferred from the distribution of hourly departures because it cannot be assumed that an equal number of landings and takeoffs will occur in any one hour.

Sunriver and Hermiston Airports are used as examples of how sampled departures data can provide information on the frequency distribution of estimated daily and hourly departures.[9]

Sunriver Airport - The distribution of daily departures at Sunriver Airport is similar to that at the majority of sampled non-towered airports in Oregon. Forty percent of the days sampled had 0-9 departures. The relative frequency of occurrence decreases for each successively higher category of departures (see Figure 1). The peak number of departures that occurred in any one sampled day was 63.



Note: The distributions are for illustrative purposes only in Figures 1-4. They are based on non-random samples and may be biased.

The ratio of peak daily departures to mean daily departures is a useful measure of the extent to which peak departures differ from mean departures. The ratio of peak to mean daily departures for Sunriver Airport is $\frac{63}{15.6} = 4.03$. Peak daily departures is four times the level of mean daily departures.

The distribution of hourly departures is similar to that of daily departures. The majority (73 percent) of hours sampled had no departures. Twelve percent of the hours had one departure. The relative frequency of occurrence continues to decrease as the number of hourly departures increases (see Figure 2). The peak number of departures that occurred in any one sampled hour was 14.

The ratio of peak to mean hourly departures is $\frac{14}{.6} = 23.33$. The ratio of peak to mean hourly departures is expected to be considerably higher than the ratio of peak to mean daily departures.

Hermiston Airport - The distribution of daily departures at Hermiston Airport is similar to that at the remaining sampled non-towered airports in Oregon. The airports in this group tend to be larger than the airports represented by Sunriver.

The distribution of daily departures is more symmetrical than that of Sunriver. The 20-29 departures category occurred with the greatest frequency. Lower and higher categories of departures occurred with successively lesser frequency (see Figure 3). The peak number of sampled daily departures was 59.

The ratio of peak to mean daily departures is $\frac{59}{23.8} = 2.48$. As expected from the shape of the frequency distribution, the ratio is lower than that of Sunriver. The gap between peak and mean daily departures is less, but peak daily departures is still over twice as large as mean daily departures.

The distribution of hourly departures at Hermiston Airport resembles that of Sunriver. No departures occurred 63 percent of the time. Higher hourly departures occurred at lower

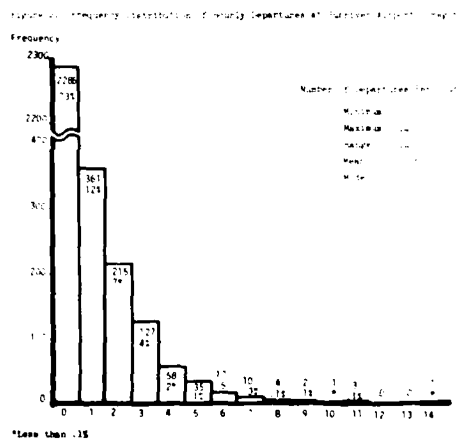
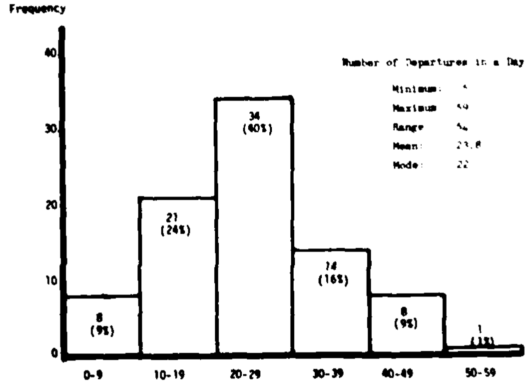
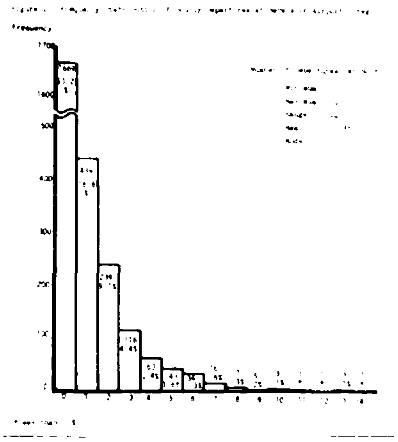


Figure 3. Frequency Distribution of Daily Departures at Hermiston Airport, Oregon



relative frequencies. Peak hourly departures, 14, occurred once (see Figure 4). The ratio of peak to mean hourly departures is $\frac{14}{.85} = 16.47$.

The similarity in the distribution of hourly departures between Sunriver and Hermiston is true of all sampled non-towered airports. No departures per hour occurred most often (63 to 98 percent of the time). As departures per hour increased, the relative frequency of occurrence decreased.



CONCLUSIONS

Acoustical aircraft activity counters can provide an accurate and relatively inexpensive method of obtaining operations data at many non-towered airports. During the Aircraft Activity Counter Demonstration Project, RENS counters were used to gather data at 37 northwestern airports. The data not only allowed accurate estimates of operations at most of these airports, but also generated data from which alternative sampling and estimating procedures can be tested. Using that data, it has been determined that procedures which combine short, one-period samples (7 to 21 day counts) with independent estimates of seasonal variation (e.g., towered airport data) to estimate operations at non-towered airports are not reliable. On the other hand, the acoustical counter allows an alternative approach of systematic sampling which is more accurate. Specific conclusions of this investigation are:

1. Operations data for towered airports are not a reliable source of data for estimating operations at non-towered airports, because the seasonal variation of operations at towered and non-towered airports are not generally similar.
2. Weather data are expected to be a good independent data source for estimating variation in operations. However, daily weather data for the non-towered airports under study must be collected for both sampled and non-sampled days.
3. Fuel sales data, if available on a monthly or quarterly basis, may also provide a good estimate of variation.
4. A seasonally stratified, systematic sample of airport operations using acoustical counters is expected to provide a good estimate of annual operations. To reduce sampling costs, a seven-day cluster sample, rather than a simple random sample, could be drawn within each season.
5. Sample size may be adjusted based on desired accuracy and available funding for the sample. Independent measures of seasonal variation of operations, such a weather or fuel data, may be used in conjunction with the sample data to increase the sample precision or, conversely, to decrease the sample size.
6. Sample data may be used to estimate the seasonal distribution of operations and peak loadings as well as to estimate annual mean and total operations.

FOOTNOTES

1/ U.S. Department of Transportation, Federal Aviation Administration, Systems Research and Development Service, Statistical Methods for Measuring Aeronautical Activity at Non-Towered Airports, Report No. FAA-RD-73-18, (Washington, D.C.: Government Printing Office, 1973), pp. 1-4.

2/ The latest edition of the Handbook available at the time of the study was for the 1978 calendar year. Sampled data from non-towered airports were obtained primarily in 1981. It is not believed the three year difference in the data significantly affects the validity of the comparison of tower and non-tower data. The distribution of operations over quarters in the 1978 Handbook was very similar to the distribution of operations in the 1975 and 1973 Handbooks. This similarity held whether operations at a given airport grew steadily between 1973 and 1978 or declined in 1975 or 1978 relative to 1973. Given the stable distribution of tower operations between 1973 and 1978, it is likely that 1981 tower operations reflect the same pattern of distribution as observed in 1978 and earlier. Therefore, the three year difference in tower and non-tower operations data is not expected to bias the comparison of tower and non-tower operations.

3/ The difference in variation between the Medford sample data and tower statistics may result from a combination of three factors: (1) the three year lag in the tower data; (2) the difference between a sample and a complete count; and (3) the fact that the sample estimate reflects all operations, while only general aviation statistics were used from the tower data.

4/ The minimum change estimate (MCE) of non-tower operations is a recommended method in the FAA Report No. FAA-RD-73-18.

5/ For this example, $\bar{y}$ is assumed to be the same as the average daily operations during the third quarter. In reality, $\bar{y}$ would be determined by the actual number of operations during the sample period.

6/ For this example, Y' equals the estimated operations report on the FAA Form 5010 for the period March 1981 through February 1982.
7/ The 13 in the equation refers to the total number of seven-day clusters in each quarterly stratum. If two or three seasonal strata were used, then 26 or 17, respectively, would be substituted for the 13. The n term would change according to the number of seven-day clusters sampled from each strata.
8/ H.D. Brunk, An Introduction to Mathematical Statistics (Lexington: Xerox College Publishing, 1975), p. 169.
9/ The distribution data for Sunriver and Hermiston Airports are provided for illustrative purposes only. They are based on a non-random sample and may be biased.

APPENDIX

METHOD FOR DETERMINING SAMPLE SIZE AND PRECISION IN TABLE 3

The expected precision or sampling error of different size samples drawn at different size airports reported in Table 3 was determined based on data obtained from the Aircraft Activity Counter Demonstration Project. First the coefficient of variation of mean daily departures was estimated for each of the 25 sampled airports. Next a simple linear regression equation was used to estimate the relationship between mean daily departures and the coefficient of variation of the estimator of mean daily departures. The estimating equation is:

$$\hat{CV}(\bar{y}) = 1.62 - 0.15(\bar{Y})^{\frac{1}{2}}, \quad R^2 = 0.76, \qquad (12)$$

where

$\hat{CV}(\bar{y})$ = estimated coefficient of variation of the sample mean of daily departures

$\bar{Y}$ = true mean of daily departures

The estimated relationship holds for values of Y ranging from 1 to 85 departures per day. For higher values of $\bar{Y}$, $\hat{CV}(\bar{y})$ does not diminish.

Values of Y are expanded into annual operations which are divided into categories. Each category of annual operations has a corresponding value of $\hat{CV}(\bar{y})$ (see Table A).

The percent of sampling error at the 95 percent confidence interval is estimated by:

$$\frac{2\ s.e.\ (\bar{y})}{\bar{Y}} = \frac{2(V\ (\bar{y}))^{\frac{1}{2}}}{\bar{Y}} \qquad (13)$$

$$= 2\left[\left(\frac{1 - \frac{n}{52}}{7n}\right)\frac{S^2}{\bar{Y}^2}\right]^{\frac{1}{2}}, \quad \text{where}$$

$s.e.(\bar{y})$ = standard error of the mean

$\bar{Y}$ = true means

$V(\bar{y})$ = variance of the mean

n = number of sampled clusters in the year

7 = number of days in each cluster

$\frac{S^2}{\bar{\bar{y}}^2} = \hat{CV}(\bar{y})^2$

The appropriate value of CV (y) in Table A, based on the size of the airport being sampled, is squared and substituted for $\frac{S^2}{\bar{Y}^2}$ in equation (13).

By using varying values of $\hat{CV}$ ($\bar{y}$) for different size airports and n for different size samples, the corresponding percent sampling error at the 95 percent confidence level can be estimated before the sample is conducted. Decisions can then be made concerning the trade-off between sample size (and cost) and desired precision of the sample.

TABLE A. VALUES OF $\hat{CV}$ ($\bar{y}$) AND $\bar{Y}$ BY LEVEL OF ANNUAL OPERATIONS
($\hat{CV}(\bar{y})$ = 1.62 - 0.15 $(\bar{Y})^{\frac{1}{2}}$)

$\hat{CV}$ ($\bar{y}$)	$\bar{Y}$	Annual Departures	Annual Operations
1.5	≤ 1.285	< 469	< 900
1.4	1.286 - 3.241	470 - 1,183	900 - 2,399
1.3	3.242 - 6.085	1,184 - 2,221	2,400 - 4,399
1.2	6.086 - 9.816	2,222 - 3,583	4,400 - 7,199
1.1	9.817 -14.441	3,584 - 5,271	7,200 -10,499
1.0	14.442 -19.951	5,272 - 7,282	10,500 -14,599
0.9	19.952 -26.351	7,283 - 9,618	14,600 -19,199
0.8	26.352 -33.641	9,619 -12,279	19,200 -24,599
0.7	33.642 -41.816	12,280 -15,263	24,600 -30,499
0.6	> 41.817	≥ 15,264	≥ 30,500

BIBLIOGRAPHY

Brunk, H.D. An Introduction to Mathematical Statistics. Lexington: Xerox College Publishing, 1975.

Cochran, William G. Sampling Techniques. New York: John Wiley and Sons, Inc., 1963.

Oregon Department of Transportation, Aeronautics Division, and Oregon State University, Survey Research Center, in

cooperation with Washington State Aeronautics and Idaho Division of Aeronautics and Public Transportation. Aircraft Activity Counter Demostration Project Final Report. Salem: Department of Transportation, 1982.

U.S. Department of Transportation, Federal Aviation Administration, Office of Aviation Policy, Aviation Forecast Branch. Tower Airport Statistics Handbook Calendar Year 1978, Report No. FAA-AVP-79-2. Washington, D.C.: Government Printing Office, 1979.

Tower Airport Statistics Handbook Calendar Year 1975. Report No. FAA-AVP-76-11. Washington, D.C.: Government Printing Office, 1976.

Tower Airport Statistics Handbook Calendar Year 1973. Washington, D.C.: Government Printing Office, 1975

U.S. Department of Transportation, Federal Aviation Administration, Systems Research and Developement Service. Statistical Method for Measuring Aeronautical Activity at Non Towered Airports, Report No. FAA-RD-73-18. Washington, D.C.: Government Printing Office, 1973.

DR. SCHWARTZ: Thank you Rosalyn. Our next speaker is Bill Tucker. Bill is the Director of Statistics and Forecasts in the Canadian Air Transportation Administration of Transport Canada. He received his Engineering diploma from Memorial University in 1964 and his Bachelor of Engineering Degree from Nova Scotia Technical College in 1966. He then served as a pilot with the Canadian Armed Forces until the fall of 1970 when he returned to school. He graduated from the University of Western Ontario in 1972 with a Masters Degree in Business Administration. During his career with Transport Canada, he has held successively more responsible positions, initially in Airport Planning, then in Civil Aeronautics Planning and Research and, since the end of 1973, in the area of Aviation Statistics and Forecasts. In his present position, Mr. Tucker provides the Canadian Air Transport Association focal point for aviation statistics and forecasts and is responsible for all official Canadian Air Transportation Association forecasts of direct aviation activity used in plans, programs or policy proposals.

GENERAL AVIATION: HOW CANADA DIFFERS FROM THE UNITED STATES

William Tucker
Director, Statistics & Forecasts
Transport Canada

SUMMARY

Mr. Tucker compares the uses and users of General Aviation in Canada and the United States. In general, Canadian air traffic patterns closely resemble their American counterparts as do Canadian forecasting methods. The Canadian Air Transportation Administration (CATA), the equivalent of the Federal Aviation Administration, uses the Canadian General Aviation Dynamics Model, a derivative of the FAA's GAD model to generate its yearly "aggregate demand indicator" forecasts. Unlike the FAA, the CATA focuses its forecasts on *specific airports.* The Canadian government owns and manages most airports and facilities in Canada.

INTRODUCTION

I would venture to guess that every person at this FAA Conference is familiar with the term "General Aviation." However, I also suspect that very few are sure of the precise definition of G.A. Well the same situation exists in Canada. But, the sub-title of my presentation is "How Canada Differs from the United States," so let's start with the definitions of G.A.

Quoting from the FAA Aviation Forecasts report, G.A. in the U.S. refers to:

> All civil aviation activity except that of certificated route air carriers and air commuter activities.

The definition adopted by the Canadian Air Transportation Administration is as follows:

> All civil aviation activities excluding Canadian Transport Commission license classes 1 and 8, 2 and 9-2 and also 3 and 9-3, 4 and 9-4 for aircraft above 12,500 lbs. gross take-off weight.

The classes mentioned above simply refer to levels of air carrier licenses. For example, Classes 1 and 8 refer to major carriers scheduled services (domestic and international) while 4 and 9-4 represent domestic and international charter services.

So you see, there is a difference in the way we define G.A. However, in both Canada and the United States, General Aviation refers to a wide variety of civil aviation activity ranging from the operation of large corporate jets to home-built single-engine piston aircraft and including gliders and balloons.

If I were making this presentation to a cross-section of the general public, I would emphasize at this point that General Aviation is not a homogeneous type of activity and that it certainly is not typified by the wealthy doctor or lawyer flying his personal aircraft for recreation. Such a reminder is not necessary for this audience, but we all should keep in mind that many of the general public have a misconception about this category of aviation.

Now, let us look at the composition of the G.A. aircraft fleet in our two countries. Table 1 compares the estimated number of active G.A. aircraft, by type, in 1982.

As you can see from this table, the ratio of the totals is roughly the same as that of the two countries' populations, (i.e. about 10 to 1). The same ratio holds true for single-engine piston aircraft which account for the great bulk of G.A. aircraft. However, there are some differences which are readily apparent from the percentage distributions in the last two columns of Table 1. In Canada, multi-engine piston, turbo-prop, and jet aircraft make up a proportionately smaller share of the General Aviation aircraft fleet. Conversely, the number of helicopters is proportionately higher in Canada and the remaining difference is made up in the single-engine piston and balloon, dirigible and glider categories.

Table 2 provides a more-detailed description of the G.A. fleet in Canada as of December 31, 1980. Unfortunately, I do not have similar figures for the United States. However, using the figures from page 14 of the latest FAA Aviation Forecast report, I have estimated that roughly 37 percent of the U.S. General Aviation fleet aircraft are purchased for business use. A similar result is obtained for Canada when you add the business-owned portion of the "Private" category to the "Commercial" category.

As a further comparison, let us look at the utilization of General Aviation aircraft. For this, I had to go back to 1978 to find comparable data, but I would suspect that the pattern has not changed significantly. Table 3 compares the estimated hours flown in General Aviation, by aircraft type. You will note that the U.S./Canada ratio in this case is somewhat higher than the 10:1 proportion discussed earlier. For number of hours flown, it is 11.6:1 compared with 10.5:1 for number of G.A. aircraft. Thus, the average annual flying hours per General Aviation aircraft is about 10 percent higher in the United States than in Canada.

A final statistical comparison, Table 4, compares the numbers of various types of pilots licenses in 1982. While the figures in this table do not pertain solely to G.A., they do provide some interesting comparisons. The ratio of grand totals is 9.2:1 This means that the number of licensed pilots per thousand of populations is slightly higher in Canada than in the U.S. This is even more pronounced for helicopter and glider pilot licenses. For powered fixed-wing aircraft the ratio is much closer to 10:1. However, there are significant differences among the categories in this subtotal. The numbers of commercial licenses and airline transport ratings are proportionately lower in Canada, while for private licenses and student permits they are higher.

The Canadian license statistics also depict the numbers of pilots by sex, so I have included these data in Table 4. Women presently account for only one percent of airline transport and helicopter licenses in Canada. For commercial licenses, the proportion of women is more than three times as high but it is still only 3.2 percent. Continuing with private licenses and student permits, female pilots represent 5.7 percent and 10.0 percent, respectively. Now, bearing in mind the normal progression from student permit to airline transport rating, you can see that there will be further increases in the percentages of women holding the higher levels of pilot licenses.

Now, since this is a forecasting conference, it is perhaps time that I moved from statistics into forecasts.

In the Canadian Air Transportation Administration (CATA) there are several types of forecasts that we produce regularly which pertain to G.A. either in whole or in part. Primary among these are our forecasts of aviation activity at the site level, which include itinerant aircraft movements for various components of General Aviation as well as local movements. The main use of these forecasts is in airport planning which is necessary since the Canadian Government owns and/or operates most of the larger airports. Where appropriate, provisions must be made for dedicated G.A. infrastructure and G.A. must also be considered in land use planning and airport planning in general. At six of our largest cities, we have designated satellite airports for G.A. only in order to reduce congestion and airspace incompatibility. For such airports, our forecasts are entirely of G.A. activity.

In addition to our site forecasts, we produce at least once a year a set of "aggregate demand indicator" forecasts. These provide an indication of the growth in demand for CATA facilities and services and are used for budgeting and strategic planning. The first three indicators relate to the total number of passengers, cargo and itinerant aircraft movements at the "Top 25" Canadian airports, and of course, air carrier and general aviation activity. The final two indicators relate to CATA's licensing and inspection responsibilities and to the statistics discussed earlier. These

are total (civil) aircraft registered in Canada and total pilots and other licensed personnel.

At the CATA, as at the FAA, we use a variety of forecasting models and methods. Our major G.A. model is CANGAD, the Canadian General Aviation Dynamic Model. This is a derivative of the GAD model which was developed for the FAA several years ago by Battelle Memorial Institute. It is used in producing national forecasts of movements, aircraft registration, and pilots. In addition, we have developed a set of one national and twelve regional models which are also used in forecasting G.A. movements. These are fairly simple but effective econometric models which are easily revalidated for our periodic "General Forecast Updates." Use is also made of time series analysis. Recently, we began using the Box-Jenkins univariate and multivariate models in the production of short term forecasts.

Table 5 presents a comparison of three of CATA's and the FAA's forecasts. The first two are not solely related to General Aviation, but they are primarily influenced by that portion of civil aviation activity. I have included forecast growth rates for both 1981-91 and 1982-91 because of the anomaly in 1982 volumes and because, for Canada, the 1982 data are incomplete. As you can see from this table, the growth forecasts are generally quite similar. The only significant difference is in the forecasts of itinerant G.A. movements for which the FAA's forecast is somewhat higher than CATA's.

Figure 1

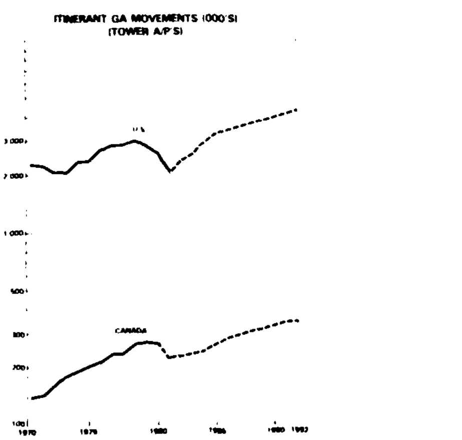


Figure 1 compares historical and forecast itinerant G.A. movements for the United States and Canada. As you can see, there has been a much sharper decline in the U.S. total since 1980. Obviously, the recent air traffic control problem has been a factor. The number of tower-airports contributing to the U.S. total has decreased from 432 in 1980 to 375 in 1982. Table 10 in the FAA Aviation Forecast report shows that this is expected to increase rather rapidly in the short term and be back to 433 towers by 1985. For the post-1985 period, the two forecasts are quite similar as shown in Figure 1.

With the above taken into account it can be concluded that the FAA and CATA have quite compatible G.A. forecasts for the period to the early 1990's.

TABLE [illegible]
CANADIAN GENERAL AVIATION AIRCRAFT, BY USER CATEGORY, (AS OF DECEMBER 31, 1980)

USER CATEGORY	TOTAL	% OF GRAND TOTAL	AIRCRAFT TYPES: AEROPLANES	HELICOPTERS	GLIDERS	GYROPLANES	BALLOONS
Private	13,698	(73.2)	13,008	153	398	64	72
Commercial	4,728	(25.3)	3,794	934	0	0	0
State	274	(1.5)	203	62	0	0	0
Experimental	25	( )	20	1	1	[illegible]	1
GRAND TOTAL	18,725	(100)	17,025	1,150	399	64	73

Source: Report on General Aviation Policy Review Project (Page [illegible]), TP 3944, Transport Canada, December 1982

TABLE 4
SUMMARY OF PILOTS LICENCES IN FORCE (1982)

TYPE OF LICENCE	CANADA MALE	CANADA FEMALE	CANADA TOTAL	U.S. TOTAL
AEROPLANES:				
Students	18,079	2,002	20,081	179,900
Private	38,057	2,284	40,341	528,600
Commercial	9,128	304	9,432	168,600
Airline Transport	6,146	63	6,209	70,300
Sub-Total (Aeroplanes)	71,410	4,653	76,063	747,400
Helicopters	2,371	21	2,392	6,500
Gliders	4,156	370	4,526	7,400
Others	134	15	149	3,000
GRAND TOTAL	78,071	5,059	83,130	764,200

Source: Canada: Summary of Personnel Licences, Civil Aeronautics, Transport Canada, 1 January 1983
U.S.: FAA Aviation Forecasts, FAA-APO-83-1 Feb 83

TABLE 5
FORECASTS COMPARISON

FORECAST PARAMETER	AVG. GROWTH RATES (%/YR) CANADA 1981-91	1982-91	U.S. 1981-91	1982-91
Total Registered A/C	2.7	2.8	2.9	3.1
Licenced Pilots	2.5	2.7	1.4	2.4
Itinerant G.A. Movements	2.3	4.3	4.2	7.6

DR. SCHWARTZ: Thank you Bill. We are going to have a quick question and answer period - 5 minutes. Are there any questions?

MR. SEYMOUR HOROWITZ, FAA: Have you tested the reliability of the counter in areas where you do have actual counts such as at towered airports?

MS. SHIRACK: I see you are sitting back there by Tom Henry. He may have put you up to this. We were talking about something similar before. Yes, in one case we did have a control tower airport where we had the acoustical counter operating and it also had the tower operations data. They weren't real similar and I can't remember and don't have the information with me as to what degree we were off. But they were off to some degree. The tower operations data was from 1978, whereas the acoustical count was from 1981. We don't believe that will cause, or will explain, a whole lot of the variation but it may be one factor.

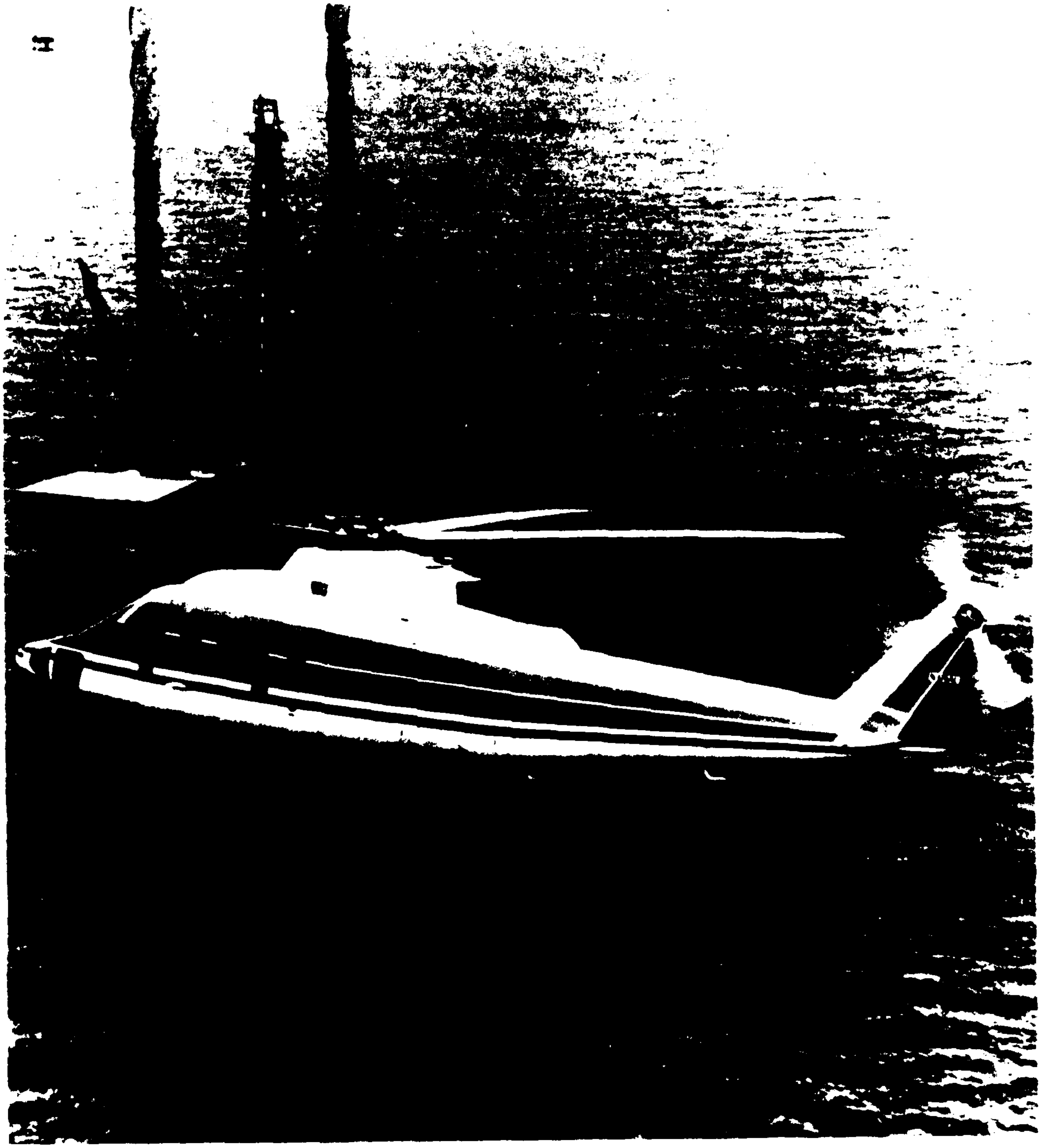
In fact, there may be a combination of about three different reasons and any one is probably very minor but in combination, they mount up. One, I believe, was the different dates the counts were taken. Two, the very fact that you have a sample count instead of a full count, a full census, is going to cause some sampling error. In the case of the Medford Acoustical Count we were finding a sample error of plus or minus about 16 percent. Whereas Tom Henry was saying he believed the difference between the operations data and the acoustical counter was greater than that. So that sampling error, by itself, doesn't account for the full difference.

So you have those two reasons and a third one was something else. With the tower operations data we were only looking at general aviation data, whereas in the Medford acoustical count, we included all operations. But the vast majority of those would be considered general aviation operations, as well. We are not really sure what that actual difference is. This is one thing we are looking at and, of course, being a demonstration project, the point of it is to surface just some issues like that to look at and try to determine why there might be some of this variation. In this one control there was some variation, but I don't think it was too terribly large. Unfortunately, I don't know the exact figure.

DR. SCHWARTZ: Any other questions? We will take a quick coffee break and then reconvene at 3:00 for the helicopter session. Thank you.

PANEL III

HELICOPTER FORECAST MODELS



INTRODUCTION

My name is Thomas Henry. I am an economist for the FAA Office of Aviation Policy and Plans. It is a very pleasant duty for me to perform the function as the panel moderator at this session. This afternoon, we will have the opportunity of hearing three distinguished, rather four distinguished, gentlemen who will speak on various aspects of planning and forecasting and modeling helicopter activities.

Our original plans called for three panelists but, as you know, forecasting is a hazardous business and anticipating a 25 to 30 percent margin of error, we overbooked this panel. We projected that the inability of one participant to attend would leave ample time for each of the other participants to do justice to his chosen topic.

Let me state up front that my confidence level in this forecast has been shaken. We have four panel members. After they have spoken we will be receptive to questions from the audience. Again, we remind you that in order that everyone can hear the questions, we would like each questioner to get close to one of the microphones. State your name and affiliation. Indicate to whom the question is addressed, and then state the question. The panelist to whom this question is addressed will respond and other panelists may expand or clarify these responses if appropriate.

At this time, I would like to introduce Colonel William Yates. Col. Yates retired from the Air Force in 1964. He is currently the manager of Petroleum Applications, Bell Helicopter - Textron, Inc., in Ft. Worth, Texas. For many years, Col. Yates was the Manager of International Market Development for the same company. Previously, he had a long and illustrious career with the military. Some of his key professional duties included: Chief Aircraft Accident Investigator, Chief Congressional Liaison, Director of Military Plans and Programs - Office of the Secretary of Defense. Col. Yates received a Bachelor of Science Degree from the University of California at Berkeley and did graduate work at the Air War College. This afternoon, Colonel Yates will describe to you the methodology he employed in assessing the U.S. and World Civil and Military rotorcraft markets for the National Aeronautics and Space Administration. Ladies and Gentlemen, Colonel Bill Yates.

HELICOPTER FORECAST MODELS

William J. Yates
Manager, Petroleum Applications, Bell Helicopter Textron Inc.

SUMMARY

Colonel Yates discusses the methodology employed in developing the forecasts of the U.S. and world helicopter markets prepared by Bell Helicopter, Textron for NASA. He describes in detail his "building block" technique in which the forecasts are developed from the ground up, taking into consideration all available information on the environment (political, military, geographic, etc.) and the data and data sources which would impact the forecasts. He recommends building the assumptions into the forecasts and being of firm convictions.

INTRODUCTION

Good afternoon. I hope my voice holds up. Mr. Henry was very kind in his introduction. He could have said "a one time fighter pilot, a sometime bureaucrat and a full time maverick." As some of you know, out where I come from in cow town, a maverick is a loner that the cow hands cannot very well keep with the herd.

I have been forecasting for a good many years, and by profession, over the past twenty-six years. Yet I am, perhaps, the least knowledgeable of anyone in this room about the subject I am to talk about - the subject being, "Helicopter Forecast Models."

I looked up the definition of "model" in a Random House dictionary. The ninth definition probably fits the art of forecasting best of all. It stated, "Logic, Math. A system of things and relations satisfying a set of axioms, so that the axioms can be interpreted as true statements about the system." - a statement clearly of obfuscation, and a delight to any forecaster determined to bewilder his reading audience.

Another definition, the first, says that a model is "a standard or an example for imitation or comparison." That is the definition I will try to follow in setting forth my presentation which will cover selection of a method of forecasting, identifying the forces which influence the forecasts, collecting and collating the historical data necessary to a sound forecast, and the actual art of forecasting.

I followed this outline in the recent study that I did for NASA titled "Assessment of Historical and Projected Segments of U.S. and World Civil and Military Rotorcraft Markets 1960-1990." (In fact, some of the projections went to the year 2000.)

SELECTING THE METHOD OF FORECASTING

As you well know, there are two fundamental approaches to forecasting. The Macro approach suggests a top-down look - using total masses of historical data, applying trend information, and deviating this trend by formulas created by trends of mass information.

And then there is the Micro approach - a look from the bottom up making a series of forecasts in building blocks and totaling them together. It is the one that creates the largest sense of confidence on the part of the forecaster because it requires observation and analysis of every building block.

The creation of mathematical formulas (for forecasting) which apply the variables is best suited to Macro forecasting. Usually, in the Micro approach, the building blocks have been broken down into such small elements that the formulas become ineffective. I, personally, have always used the Micro approach and have never been able to create satisfactory formulas which can stand the light of day.

The technique that I use is to select the building blocks. I then develop the historical trends in each block. I next analyze the factors which have influenced the historical trends and those that will influence future trends. I then apply these with subjective judgement to make a forecast for each block.

[illegible]

HELICOPTER MISSIONS

COMMERCIAL AND CIVIL GOVERNMENT	MILITARY AND PARAMILITARY
AGRICULTURE	OBSERVATION & RECONNAISSANCE
FOREST MANAGEMENT	COMMAND & CONTROL
CONSTRUCTION	[illegible]
ELECTRICAL	BATTLEFIELD SUPPORT
[illegible]	ATTACK
FIRE	MEDICAL EVACUATION
[illegible]	[illegible]
[illegible]	ANTI-SUBMARINE WARFARE
[illegible]	[illegible]
[illegible]	SEARCH AND RESCUE
[illegible]	[illegible]
MINING	SPECIAL OPERATIONS
[illegible]	TRAINING
[illegible]	
[illegible]	
[illegible]	
[illegible]	

For the forecast which was the basis of the NASA study, I broke the world down into 75 key countries and a group called "other." Within each country I broke the blocks down into 18 commercial and civil government helicopter

TAB II

HELICOPTER CLASSES

I S	1/3	SEATS	SINGLE ENGINE
II S	4/6	SEATS	SINGLE ENGINE
II M	4/6	SEATS	MULTI-ENGINE
III S	7/10	SEATS	SINGLE ENGINE
III M	7/10	SEATS	MULTI-ENGINE
IV S	11/16	SEATS	SINGLE ENGINE
IV M	11/16	SEATS	MULTI-ENGINE
V S	17/28	SEATS	SINGLE ENGINE
V M	17/28	SEATS	MULTI-ENGINE
VI M	29+	SEATS	MULTI-ENGINE
VII	DEDICATED ARMED HELICOPTERS		

TAB III

EXAMPLES OF HELICOPTER MODELS WITHIN CLASS

CLASS II S - 4/6 SEATS - SINGLE ENGINE

BELL 206A/206A-B/206B/OH-58A

HUGHES H369/H-[illegible]/OH 6

AEROSPATIALE SA 317/SA 318/SA 341/SA 342/SA 315

CLASS IV M - 11/16 SEATS - MULTI-ENGINE

BELL 212/412

SIKORSKY S-76

CLASS V M - 17/28 SEATS - MULTI-ENGINE

BELL 214ST

SIKORSKY S-58T/S-61/SH-3/HH-3/S-70/LAMPS

AEROSPATIALE SA 330/SA 332

WESTLAND WESSEX/WG 30/WG 34/SEA KING

missions (see Table I). I then broke the missions down into classes of helicopters (see Table II). These then became the building blocks with which I built the forecast. After the class forecast was made, I then applied judgement to break the forecast down into manufacturers' models. (See Table III.)

IDENTIFYING THE INFLUENCES ON FORECASTING

To me, an environmental analysis is critical to any marketing forecast. For the NASA study I analyzed the climatic, geographic, technical, economic, military, political and social environments for each of 75 countries.

The Climatic Environment analysis included, for selected country locations, five temperature, humidity, and rainfall factors (see Table IV), all of which have a direct bearing on helicopter performance in terms of reserve power requirements to offset high temperatures, space and weight provisions for instruments, and redundant systems for IFR flight (to include multi-engine vs. single engine).

The Geographic Environment analysis included eight factors of area, altitude and distance (see Table V), which also have a direct bearing on helicopter requirements in terms of range, reserve power for high altitude flight and hostility of terrain (water/jungle/ swamp) suggesting multi-engine vs. single engine configuration.

The Technical Environment analysis was two phased. The first was concerned with the degree that the customer has been exposed to, and has a desire for, advanced technology such as composite materials, fiber optics, and microelectronics, or would he prefer proven equipment that has been in production for a number of years.

The other phase of the technical environment has to do with balance of trade. The 10-fold price increase of oil during the last decade has forced the world into groupings of "have" countries who are able to generate a favorable balance of trade and the "have not" countries who must restrict import of capital goods (helicopters) to alleviate trade imbalance. The "have" countries generate their favorable trade balance by exporting oil, other raw materials (copper/coffee/gold/etc.) or technology.

The Economic Environment analysis included ten factors whose trends impacted on helicopter sales (see Table VI) in terms of mission requirements, customer ability to buy, price selection between manufacturing countries, and import restrictions. For example, the current collapse of the French franc against the U.S. dollar is "eating our lunch" until the resultant inflation in France, coupled with their high cost of import of raw materials, will drive their export prices back up again.

The Political Environment analysis included world alliances such as the United Nations and its committees (i.e., Sea Beds), the North Atlantic Treaty Organization, the Organization of American States, and many others. It also included bi-lateral agreements between countries for mutual defense. It also included statements of current policy. For example, in 1979 Brazil was "hostile to the U.S. government over civil rights."

The Military Environment analysis included a statement of the internal threat (subversion), a statement of the external threat (i.e., Greece and Turkey have a history of conflict and an intense mistrust of each other's acquisitional intentions), a listing of the historical, current and projected helicopter force objectives by mission and quantity, and a listing of historical defense budgets in relation to total government expenditures.

The Social Environment analysis included historical trends of population of the country and of major cities, the countries which were

the source of heritage, and the per capita domestic product. In the third world, an attempt was made to evaluate the social pressures brought on the national government for programs such as increased agricultural production, increased police activities to protect the status quo, and increased health programs (all offering potential markets for helicopters).

TABLE IV

CLIMATIC FACTORS IN HELICOPTER FORECASTS

AVERAGE TEMPERATURE RANGE
ABSOLUTE TEMPERATURE RANGE
RELATIVE HUMIDITY RANGE
RAINFALL RANGE (INCHES/YR)
RAINFALL RANGE (DAYS/YR)

COLLECTING AND COLLATING DATA

Collecting basic data for forecasts can be an odious task. Collating it has been made easy by computers.

To generate the data base from which the NASA study was derived, we selected 13 pieces of information for each helicopter (see Table VII) which identified it as to location, owner and mission. Our sources were our own Bell files, U.S. Military records, national AIA Export information, some 45 civil registries, about 26 key trade publications, U.N. publications, and Bell staff (Regional Managers/Country Dealers/Service Representatives).

TABLE V

GEOGRAPHIC FACTORS IN HELICOPTER FORECASTS

COUNTRY AREA
AREA ABOVE 1000 METERS
MAXIMUM OPERATING ALTITUDE
LENGTH OF COASTLINE
MEAN WIDTH OF CONTINENTAL SHELF
MAXIMUM WIDTH OF CONTINENTAL SHELF
TERRITORIAL WATERS CLAIMED
DISTANCE BETWEEN MAJOR CITIES

TABLE VI

ECONOMIC FACTORS IN HELICOPTER FORECASTS

[illegible]
[illegible]
TOTAL [illegible]
[illegible] INDEX
[illegible] INDEX
[illegible]
[illegible]
[illegible] INDEX
[illegible] RATE
INTERNATIONAL [illegible]
[illegible]

TABLE VII

HELICOPTER DATA INFORMATION

MANUFACTURER - MAIN OR LICENSED
MODEL
SERIAL NUMBER
[illegible] TAIL NUMBER
COUNTRY
OWNER
MARKET [illegible]
MISSION
PRICE (NEW)
STATUS (ACTIVE, DESTROYED, [illegible])
THE STARTING DATE OF THE ABOVE INFORMATION
THE ENDING DATE OF THE ABOVE INFORMATION
THE METHOD OF TRANSFER [illegible]

The basic data were fed into the Bell main computer bank covering all identifiable helicopters manufactured outside of the USSR between 1946 (the date of the first civil registry of a helicopter) and 1980.

Helicopter data covered 52,000 helicopters and 125,000 transactions (change in location/ownership/mission/ status).

The economic data (Table VI) were also fed into the computer.

The historical data were then collated into many combinations for later analysis such as summaries of deliveries or inventories by year/market/mission/manufacturer/model, by year/market/owner/ manufacturer/model, or by year/market/mission/class.

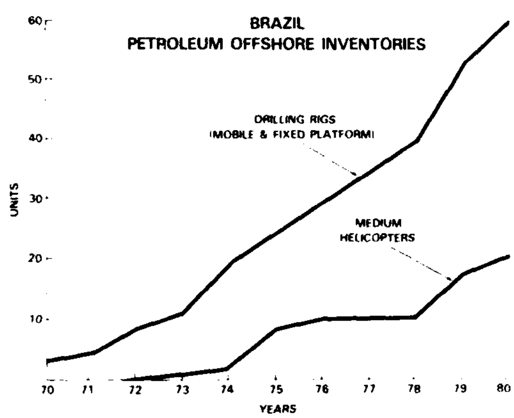
FORECASTING

Once all of the basic data for a building block have been gathered and collated, and the influences which will affect the forecast for the building block have been identified and isolated, it is necessary for the forecaster to immerse himself completely in the details - and stay immersed.

The closer a forecaster can identify with the buyer or end user, the better will be the forecast. He must learn as much as possible about the end user's environment, his resources (physical and mental) and his prejudices. For example, Schreiner, a helicopter operator predominantly based in the Netherlands, buys French equipment. The Peruvian Air Force buys mostly from Bell. Many navies of the world are Sikorsky-oriented.

Let's look at an example of the building block, medium helicopters (Class IV M) in support of offshor xploration in Brazil (see Table VIII). Medium helicopters are required to change the drilling crews. The ratio for Brazil is fairly close to one medium helicopter for three drilling rigs. The task then is to determine the exploration and development plans of Petrobras, the national oil company, to determine their planned growth in rigs. A more difficult task, and much more subjective, is to determine when and how many helicopters will be bought for fleet upgrading to add to fleet growth. Another subjective task is to determine which models in what quantities will be procured.

Once saturated with building block historical data and environment, a forecast is readily made. The total forecast is a simple tabulation of all of the building blocks.



There are some do's and don'ts that, as an old timer in the forecasting game, I would like to pass on to you.

Don't make assumptions. If an anticipated event will affect the forecast, make the happening of the event a part of the forecast.

Don't make High-Low forecasts. Use your best judgement at the time and make a single positive forecast. If you are uncertain, go back and roll in the data and environment some more. If by then you don't have a strong opinion, then you should not be in forecasting. The great World War II General, George C. Marshall, had a statement that I paraphrase, "in solving any problem, if the facts are clearly determined and understood, the solution is self-evident."

Don't review your previous forecasts against current events to see how accurate you were. It can erode your self confidence. Remember the statement of the immortal baseball player, Satchel Paige, "Never look back, something might be gaining on you!"

It helps a forecaster to have a tough hide. Upper management has a considerable number of people who got there by avoiding taking a position on any subject. These are the hind-sighters who will pick and scratch at your trail through the "chicken coop."

Keep your strong convictions and prejudices. They were created by long experience and probably have a very sound basis. An open mind is suggestive of indecision.

Live with your historical data and environmental information. Today I pursue the offshore petroleum helicopter market. I keep a 10 year file around me of data on thousands of leases and wells and hundreds of mobile drilling rigs, permanent platforms and construction and service boats, all of which require helicopter support.

Good hunting and good luck in your quest for an ultimate forecast.

MR. HENRY: It is now my pleasure to introduce to you Dr. Benjamin Loret, Vice President, Applied Systems Institute, Inc., a Washington based consulting firm. As Vice President, his responsibilities include project management, management consulting, design and development of management information, automatic data processing systems and the design and conduct of analytical studies. Before joining ASI, Dr. Loret served as Vice President within the Federal Systems Division, Science Management Corporation. There, he directed the execution of contracts with Federal agencies for the provisions of automatic data processing and consultant services related to management information systems. Dr. Loret also served in responsible positions with other organizations, such as Computer Sciences Corporation, the Defense Communications Agency and the Office of the Secretary of the Air Force. Dr. Loret received his Doctorate in Business Administration from George Washington University. He acquired M.S. and M.B.A. degrees from the Air Force Institute of Technology and New York University, respectively. He is a graduate of the U.S. Military Academy, as well as a professional engineer. He has published articles on the design of space vehicles, manned orbiting space stations and inter computer networks. This afternoon, Dr. Loret will present the results of some exploratory contract research on econometric models for forecasting helicopter activities. Ladies and Gentlemen, Dr. Loret.

AN EXPLORATORY ECONOMETRIC MODEL FOR HELICOPTER ACTIVITY FORECASTING

Benjamin J. Loret
Vice President
Applied Systems Institute, Inc.

SUMMARY

Dr. Loret presents the results of an exploratory effort on the use of econometric models for forecasting helicopter activity. Specifically, he demonstrates the applicability of several multiple regression equations to historical data on total and civilian helicopter fleets, and hours flown. He recommends further research in areas such as regional analysis of helicopter activity and analysis of civilian helicopter activity by primary use categories.

INTRODUCTION

Thanks, Tom. I was quite surprised not having known Colonel Yates before since we are both ex-fighter pilots and one wonders what we are doing here dealing with helicopters. I know my own experience has led me to believe that if it doesn't have six wings on it I don't want to climb into it. But even fighter pilots have to eat, so here I am and here is Colonel Yates.

This report summarizes results of an initial effort to develop an exploratory econometric model for helicopter activity forecasting. The study was conducted under contract with the FAA during 1981.

The objective of the study was to obtain a statistically reliable model for forecasting helicopter traffic in the United States. The forecasts can be used by the FAA for planning and prioritizing developments to provide helicopter operators with safe and efficient use of navigable air space. Accurate, statistically reliable forecasts of helicopter activity would obviously be no less useful to regional, state, and local planners, to the helicopter manufacturing industry, and to helicopter operators.

The study was conducted in several stages, as follows:

(1) A survey was made of the industry as a whole, including historical data from 1960 onward. Results included compilation of data and trends for military and civilian helicopters in such categories as helicopter production (by manufacturer), registered fleet (by type of engine), changes in production (by capacity, weight, speed, price, and range of civilian helicopters), major uses of helicopters, and exports/imports.

(2) Economic, technical, and operational policy issues were identified and evaluated in terms of their potential impact on growth of the helicopter industry in future years. The economic issue addressed was the principal one of economic viability of the industry in competition with alternative modes of transportation. Technological issues considered were IFR versus VFR capability, speed, range and payload. Operational issues considered were noise and safety.

(3) As the final step preparatory to synthesis of an econometric model, data needed for the model were collected and evaluated in terms of continuity, consistency, and discrepancies. Major sets of data required for forecasting growth in helicopter usage were identified and catalogued, including production data for civilian and military helicopters, and fleet-size data. The data were then examined in the context of forecasts of the helicopter fleet made by others, i.e., FAA, Bell Helicopter, and Defense Marketing Services.

(4) Based on evaluation of the information gathered in the preceding steps, several economic models predicting helicopter activity were developed and calibrated for the years 1968-1980 based on actual data for those years. Formulation of the models, selection and testing of economy-based "predictor" variables used in the models, and results obtained are the topics of primary interest in this report.

ECONOMETRIC MODELING TECHNIQUE

In simplified terms econometric modeling involves the following sequence:

(1) Postulation of a model, i.e., a regression equation, which, in this case, takes the form:

$$y = a + b_1x_1 + b_2x_2 + b_3x_3 \ldots + b_nx_n + e$$

in which:

- "y" is the dependent variable to be forecast by the model equation. It represents the demand for a flow of helicopter services over time. This demand is not directly observable. Therefore, in this study, the demand for helicopter services was measured in terms of other

variables; such as the number of helicopters in the total active fleet and, alternatively, the number of hours flown by the total active helicopter fleet. It is in this context that we use the term "demand" or "demand for helicopters" in this report.

- The $x_1, x_2, x_3, \ldots, x_n$ are independent variables which are based on various economic measures anticipated to have a logical relationship to; i.e., they "predict," helicopter demand. These may be referred to as "predictor variables."

- The coefficients $b_1, b_2, \ldots b_n$, determined both in magnitude and sign (+or-) by the computer during the regression analysis, are measures of the change in helicopter demand with respect to a unit change in the independent variable to which each is assigned. Each coefficient is a measure of the sensitivity of demand to small changes in value of its respective predictor variable.

- The constant "a" is the y-intercept of the equation, determined during regression analysis, as is the residual error "e."

(2) Candidate independent variables are then selected for trial in the model. The criteria for selection are:

- that the predictor variable bear some logical relationship to helicopter demand, in economic terms, and
- that reliable data on the variable be available for the years to be encompassed by the model.

(3) The values for the selected variables are then inserted into the computer on a year-by-year basis, together with the actual values of demand for the corresponding years.

(4) The computer then performs a least-squares regression analysis, substituting trial coefficients for each of the predictor variables, and calculating the residual error for each trial. The regression is iterated until an equation is found which contains the smallest residual error, i.e., which represents a "best fit" to the historical data. The result is a computer printout of the "best fit" model equation, with constant "a," the coefficients of each of the predictor variables, and the residual error specified. As will be seen from the discussion of results below, the best-fit equation is quite illuminating in terms of:

- the degree of fit of the model to the total number of helicopters in the active fleet and the total number of hours flown.
- the contribution, if any, and the value of each of the individual predictor variables in predicting the total helicopter fleet and the number of hours flown, and
- the availability of measures of statistical validity and reliability of the results obtained.

SELECTION OF CANDIDATE ECONOMIC PREDICTOR VARIABLES

Some 22 candidate predictor variables were identified and tested, and were either adopted or discarded depending on their predictive value as determined during regression analysis. An appreciation of the types of variables used may be obtained from discussion of the various categories from which they were drawn.

- Measures of Economic Activity. On the basis that increases in general business activity would tend to increase the demand for helicopter services, economic measures such as Gross National Product (GNP), Personal Disposable Income, Total Employment, and Labor Productivity (GNP divided by Total Employment) suggest themselves as candidates for predictor variables. For all of these a positive relationship would be anticipated, on the basis that increases in general economic activity would tend to increase the demand for helicopters (as well as, generally speaking, the demand for all other goods and services).

- Prices of Helicopters. In accordance with fundamental economic theory, an increase in the price of helicopters will tend to lessen the demand for helicopters. Thus, the price of helicopters is a logical choice as a predictor variable, in this case being inversely related to demand. A negative sign for the coefficient of this variable may be postulated--as prices go up there will be fewer helicopters in the fleet (and conversely). To eliminate the effects of inflation during the period covered by the model, this variable and others expressed in dollar terms were converted to constant dollar prices (1972 prices were used throughout) so that only relative changes in prices would be considered by the model in predicting demand.

A second price-related variable used as a predictor was price deflated by labor productivity. It may be anticipated that an increase in price, if accompanied by an increase in labor productivity, may not necessarily result in a lowering of demand. If, for example, innovations and/or technological improvements result in a helicopter with much greater capacity or operational capability, these improvements (attributed to increased labor productivity) may compensate for (or more than compensate for) the price increase, resulting in unchanged or even higher demand despite the price increase. Various combinations of price changes and labor productivity changes may be taken into account by using a predictor variable defined as price divided by labor productivity. Both price and price deflated by labor productivity were used as predictors in the models developed during the study.

- Industry Specific Variables. These are economy-based variables closely related to helicopter activity, such as the number of offshore gas and oil wells and employment in the oil and gas exploration industries, both of

which involve extensive use of helicopters. These predictors would be expected to have positive relationships with demand, whereas other helicopter industry-specific variables that might be used, e.g., price of helicopter fuel and helicopter accident rates, would be expected to be inversely related to demand.

- Existing Stock of Helicopters. As is often the case in econometric modeling, the existing stock of the dependent variable (last year's inventory) tends to influence the current year's inventory. In other words, it may be postulated that the more helicopters there are, the more there tend to be. Based on the experience that a "lagged-dependent variable" tends to be a good predictor, the number of helicopters in the previous year's active fleet was identified as a predictor for the following year.
- Number of Heliports. An increase in the number of facilities to handle helicopter traffic would logically tend to result in an increase in the number of helicopters which use them. Accordingly, the number of heliports was used as a predictor variable, with a positive relationship to demand postulated.

The above and other economy-based variables were identified and tested for their predictive quality. Some were dropped for poor predictive value or lack of statistical significance. The remaining ones were grouped in various combinations and were used to obtain the results described below.

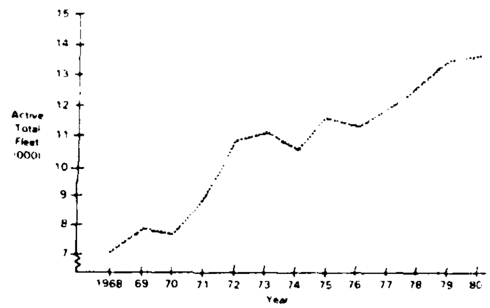


FIGURE 1 ANNUAL ACTIVE TOTAL FLEET OF HELICOPTERS, 1968-1980
(Source FAA Statistical Handbook of Aviation)

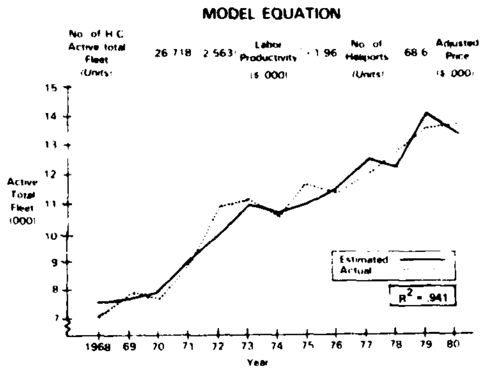


FIGURE 2 ACTUAL AND ESTIMATED VALUES FOR ACTIVE TOTAL FLEET 1968-1980

EXPLORATORY MODEL RESULTS

Figure 1 depicts the actual number of active helicopters against which results obtained from the exploratory model may be measured. The plot is of the number of helicopters in the total active fleet (in thousands) for each of the years 1968-1980. The data points may be viewed as the observed demand for the fleet of active helicopters at various points in time. From this perspective, the data points seem to represent shifts in the "demand curve" for helicopters over time.

The objective of the study was to define a model or models which would generate or predict this set of data points based on independent economy-based variables, using the actual values of those variables over the same time period. It should be noted that no attempt was made to forecast the active fleet in future years, but merely to develop a model which would "explain" what happened historically.

Figure 2 depicts the results obtained using the "best fit" model equation shown at the top of the figure, superimposed on the historical data taken from Figure 1. The equation predicts the active helicopter fleet based on three independent variables: Labor Productivity, Number of Heliports, and Adjusted Price of Helicopters. The interpretation is as follows:

- Labor Productivity is positively related to the demand for helicopters as shown by the (+) sign. Specifically, the coefficient 2,563 tells us that for every 1,000 increase in labor productivity, the active total fleet will increase by 2,563 helicopters.

- Similarly, for every additional heliport added to the existing number of heliports, 1.96 (nearly two) helicopters will be added to the fleet.

- Finally, for every $1,000 increase in price per helicopter (price deflated by labor productivity), there will be a drop of 68.6 helicopters in the total active fleet. As anticipated, the relationship is inverse, as indicated by the (-) sign.

As may be seen, the "fit" of estimated data to the historical data is statistically quite good, as indicated by the R^2 value (corrected for degrees of freedom) of .941. The R^2 measure indicates that 94 percent of the variation in the historical data can be explained in terms of the three predictor variables shown in the model equation.

Two other points may be made which help explain the model and the results shown. The constant -26,718 (which represents the *y-intercept*) has no practical significance and may be ignored, its effect being merely to raise or lower the estimated curve vertically to match the actual curve. The "goodness of fit" is determined, instead, by how well the kinks in the estimated curve follow the kinks in the actual curve, which is determined by the predictor variables and their coefficients.

The predictor variables were found to be statistically significant at the 90 percent or greater level (t = 1.5). That is, there is a better than 90 percent probability that the relationships depicted by the coefficients in the model are true relationships rather than being due to chance. Except where noted, all the coefficients reported herein met or exceeded the test for statistical significance at the 90 percent level.

Figure 3 depicts results obtained using a model equation in which the number of offshore wells, the price of helicopters, and labor productivity are used as predictors. The coefficients indicate that an increase of 1,000 offshore wells would result in an increase in the active fleet of .58 helicopters. Similarly, an increase of 1,000 in the real price of helicopters would result in a decrease of 4.4 helicopters, and an increase of $1,000 in labor productivity would result in an increase of 1.241 helicopters. The R^2 value for this model is quite high, .943.

Figure 4 shows similar results, with an R^2 value of .965 when state and local employment, labor productivity, and price are used as predictors.

Figure 5 depicts a very excellent fit between estimated and actual stock of civilian helicopters (R^2 = .972) when number of offshore wells, pipeline employment, and number of heliports are used as predictors. As may be seen, the number of civilian helicopters is quite sensitive to pipeline employment, the fleet increasing by 1.83 helicopters for each increase of 1,000 pipeline workers.

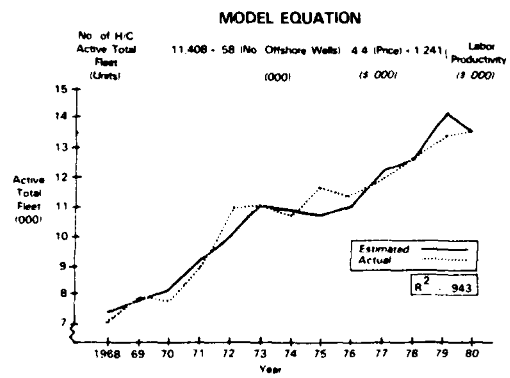


FIGURE 3: ACTUAL AND ESTIMATED VALUES FOR ACTIVE TOTAL FLEET

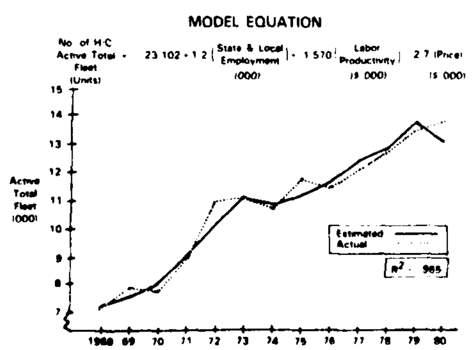


FIGURE 4: ACTUAL AND ESTIMATED VALUES FOR ACTIVE TOTAL FLEET

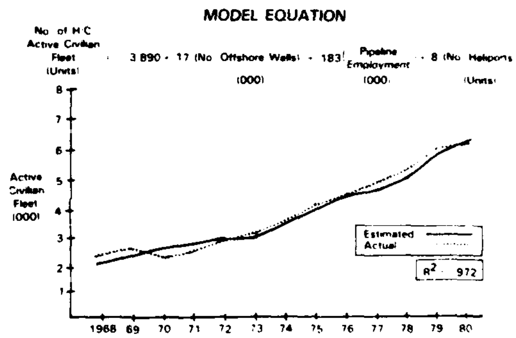


FIGURE 5: ACTUAL AND ESTIMATED ACTIVE CIVILIAN FLEET

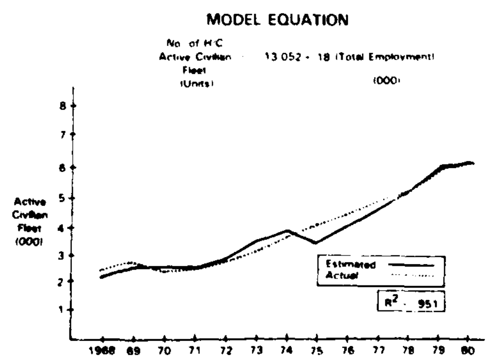


FIGURE 6: ACTUAL AND ESTIMATED ACTIVE CIVILIAN FLEET

Figure 6 illustrates that the single variable, total employment, does an excellent job of predicting demand for civilian helicopters, with over 95 percent of the variation being explained

by variations in total employment. It may be concluded from this finding that the size of the active civilian helicopter fleet is highly related to the economic activity of the nation as a whole.

Turning to the demand for military helicopters, Figure 7 depicts the results obtained when the number of military helicopters in the previous year's fleet, labor productivity, and the price of military helicopters are used as predictors. The results here are not as impressive as in the previous cases, although better than 75 percent of the variation in the number of active military helicopters can be accounted for in terms of the three predictor variables shown.

No good relationships were able to be established for total helicopter hours flown, although good fits were found for civilian hours flown and military hours flown when each was treated separately. The findings show that, as might be anticipated, different factors affect the number of helicopter hours flown in the civilian versus military environment. Accordingly, the best method for predicting total hours flown would involve adding the two independently derived forecast totals together.

Figure 8 depicts the best fit curve for total civilian hours flown (in thousands of hours) based on use of number of helicopters in the active fleet, the number of offshore wells, the number of heliports, and the adjusted price of civilian helicopters as predictors. The (NS) indicators under the last three predictor variables signify that the coefficients for these variables were not statistically significant and hence should not be relied on. The coefficient of the remaining variable, which was statistically significant, indicates that on the average an increase of 300 hours per year of flying time are logged per unit increase in helicopters in the civilian active fleet. The fit is excellent (R^2 = .922).

Similar results are obtained when number of helicopters in the active civilian fleet and number of offshore wells are used as predictors (Figure 9). As in the previous case, only the coefficient of the first variable, indicating an increase of 310 hours flown per year for each helicopter added to the active civilian fleet, is statistically significant. The minor difference in values of the coefficients (310 versus 300 in the previous equation) attests to the validity and consistency of econometric methodology.

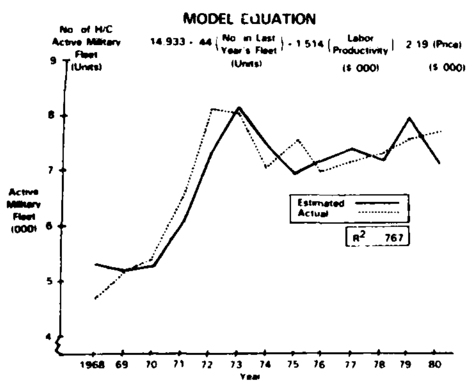


FIGURE 7 ACTUAL AND ESTIMATED ACTIVE MILITARY FLEET

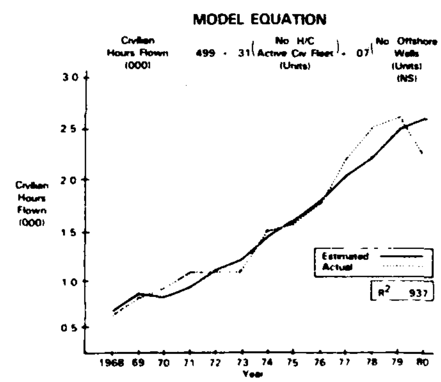


FIGURE 9 ACTUAL AND ESTIMATED CIVILIAN HOURS FLOWN

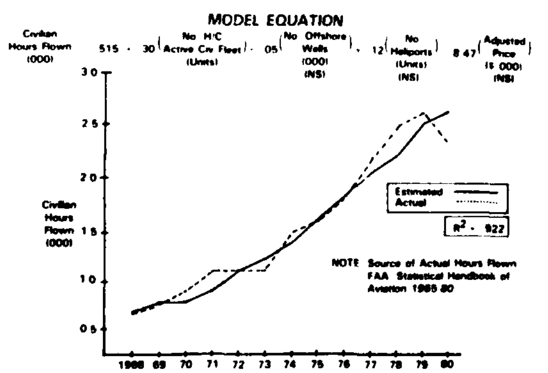


FIGURE 8: ACTUAL AND ESTIMATED CIVILIAN HOURS FLOWN

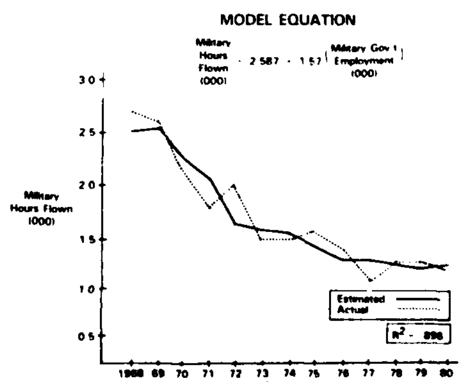


FIGURE 10 ACTUAL AND ESTIMATED MILITARY HOURS FLOWN

Figure 10 depicts the fit obtained for military hours flown (in thousands) when military government employment (uniformed members of the armed services, in thousands) is used as a single predictor variable. Figure 11 shows similar results when military government

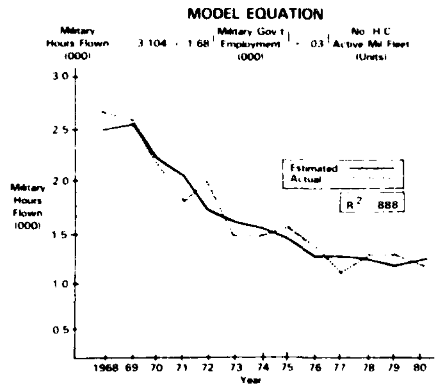


FIGURE 11: ACTUAL AND ESTIMATED MILITARY HOURS FLOWN

employment and number of helicopters in the active fleet are used as predictors. The coefficient of the latter variable indicates that, on the average, an increase of only 30 hours of flying time per year are logged for each helicopter added to the active military fleet, which is only ten percent of the corresponding figure for civilian helicopters.

THE EXPLORATORY MODEL: SUMMARY

The results presented in the figures support the conclusion that econometric techniques are clearly useful for forecasting total active fleet and hours flown. Some good, economy-based predictor variables have been identified for forecasting helicopter fleet and hours flown. These include the following, with their relationship to demand for helicopter service indicated as positive (+) or negative (-):

- Gross National Product (Deflated) (+)
- Employment (+)
- Prices of Helicopters (Deflated) (-)
- Prices of Helicopters (Deflated for Labor Productivity) (-)
- Prices of Substitutes for Helicopter Service (+). (These variables were not used in the exploratory model, for lack of data, but are anticipated to have good predictive value.)
- Industry-Specific Variables
  - Number of active, producing offshore oil wells (+)
  - Employment in oil/gas exploration (+)
  - Employment in oil/gas pipelines (+)
- Existing Stock of Helicopters (+)
- Number of Heliports (+)

ADVANTAGES OF THE ECONOMETRIC APPROACH TO FORECASTING

The study has demonstrated that econometric modeling is a useful tool for making helicopter industry forecasts, providing the forecaster with several significant capabilities not available when using other forecasting techniques:

- An econometric forecast does not require the assumption that the historical trend in the number of helicopters will continue. Because the equation is estimated from historical data, it necessarily reflects historical responses to "causal" variables, but each of these provides only a partial response. The model assumes, for example, that the partial effect of changes in real GNP will remain the same, presuming other factors do not change. But other factors, like prices, could increase and, hence, decrease the demand for helicopter services. The major impact on future growth of the helicopter fleet and hours flown is likely to be of the same variety, involving different changes for each of the predictor variables, and these individual effects are captured by the econometric forecasting model. In contrast, they are not accounted for in any rigorous, quantifiable manner by other forecasting methods.

- A major drawback of alternative forecasting techniques is that none of them specify the changes to be expected in the underlying predictor variables, or the impact that these changes will have on the future helicopter fleet. Consequently, there is no way that these forecasts can be objectively evaluated without going through the entire process of constructing alternative forecasts. On the other hand, all of these changes and their impacts on demand are fully specified in an econometric forecast. This permits one to challenge the assumptions regarding the future changes in the predictor variables that are built into the forecast, and to determine the impact on the forecast if alternative assumptions are made. For those predictor variables subject to policy control (e.g., the number of new heliports to be built, the impact

of deregulation, a system of charges for operations, the increased use of IFR instead of VFR equipment), the model also provides the ability to determine the impact of alternative policy scenarios.

- A distinct advantage associated with an econometric forecast is that it quantifies the probable error associated with the forecasting equations. Knowledge of the magnitude of the probable forecast error permits more rational system planning. In particular, this probable error could be an important consideration in comparing the costs of over-building versus under-building helicopter production capacity by all the firms in the industry.

- Another advantage of structural econometric modeling is that it can be tested for its stability prior to its use in forecasting. The stability test can be done by simply excluding some observations from an equation and comparing the coefficients and their respective measures of statistical significance with those of the full set. If the two sets of values are not significantly different from each other, as was the case for the equation shown in the figures for the years 1967-1978 when compared with the years 1967-1980, the model is said to be stable and therefore suitable for forecasting future helicopter activity.

- Perhaps most importantly, a structural econometric model provides an extremely flexible forecasting and analytical tool. Econometric modeling permits analysis of the impacts of alternative helicopter policy scenarios, particularly when there are only a few major firms producing a considerable volume of output, as is true of the helicopter industry. In addition, econometric forecasting models allow the impact of sudden changes in the economy and the aerospace industry to be assessed quickly. The importance of this advantage can be illustrated in terms of the impact of the end of the war in Vietnam on demand for military helicopters or that of the Arab oil embargo of October 1973 and the recession of 1974 on demand for civilian helicopters. If the U.S. helicopter industry had had an on-going econometric forecasting model in operation at those times, it is likely that they would have forecast sales for the late 1960's and the mid-70's more accurately. Such assessments can be made quickly using an econometric model simply by re-running the model to provide for fast-breaking changes, e.g., a relatively reduced defense budget or a reduced GNP. Sudden shocks are not easily or quickly accommodated with any degree of precision, if at all, using less sophisticated forecasting techniques.

THE ROLE OF JUDGEMENT IN ECONOMETRIC FORECASTING

Econometric models will not supplant judgement in the forecasting process. Rather, econometric models provide a means to incorporate, in a more rigorous and quantifiable manner, the informed judgement of the forecaster. Establishment of the forecasting model itself requires the exercise of judgement in selecting the predictor variables to be considered and in specifying the measurement of these factors. In addition, the forecaster must judge what will be the most likely changes in the predictor variables over the forecast interval. Finally, not all components of total system demand necessarily lend themselves to econometric modeling. To the extent they do not, these components must be forecast in some other way, usually depending on the judgement of the forecaster. A possible example of such a component for helicopter demand is the foreign or export demand for helicopters, which needs to be added to the domestic demand for helicopters.

Similarly, there remains an important role for other forecasting techniques, especially the "building-block" or component forecasting procedure--that of providing corroboration or refutation of the econometric forecast. At best, prediction is an uncertain business, and the reliability of any forecast is improved if obtained by two entirely different methods. The usefulness of the "building-block" or component technique is probably greatest in this regard, because it forces the forecaster to examine many of the long-term aggregate forecasts, such as the implied change in the use of helicopters for offshore wells, and whether that change is consistent with the probable availability of offshore oil and gas reserves.

RECOMMENDATIONS FOR FUTURE EFFORT

The initial research on an exploratory econometric model was devoted entirely to historical analysis and did not involve use of the model to project future demand. What was done was to formulate model equations which could explain demand for the years 1968-1980, for which actual demand was known. The initial task is complete, having yielded model equations which fit historical demand very well and which, having passed the test of stability, are ready for use in forecasting future demand.

Obvious next steps, in addition to forecasting total U.S. demand for the future (1983-2000), are to employ the model for forecasting at regional levels, and by primary use. The latter categories of forecasting are addressed below, along with discussion of the need for both economic and operational data to support the forecasting activity.

REGIONAL HELICOPTER ACTIVITY ANALYSIS

Although forecasting of aggregate U.S. demand for helicopters, to which this study was devoted, is worthwhile in its own right, there is a clear need for analysis of demand on a regional basis. To do so it is necessary to divide the nation into specific regions where the helicopter activity is concentrated. For instance, there is considerable concentration of helicopter activity in the regions that have relatively large oil and gas reserves. These are the Gulf Coast, the Pacific Coast, the New England Coast, and Alaska. Hence, the states composing these regions, such as Texas and Louisiana for the Gulf Coast, can be grouped as a region. The helicopter activity in the region, including the number of helicopters and hours flown, can be analyzed in terms of socio-economic factors localized for the states concerned. These factors would include population, employment by industry, personal income of the states or per capita personal income, and the number of "active and producing" offshore wells in the region.

The forecasts of regional helicopter activity can be based on regional predictor variables, leading to possible findings that the growth rates of helicopter activity for individual regions may be considerably higher (or lower) than that of the nation as a whole. Such analyses can help regional authorities, including state governments and the FAA centers, plan their activities based on specific regional trends. Such a planning exercise could include the expected increase in work load of air traffic controllers due to the increase in IFR-equipped helicopters. They could also help state governments of the region in planning the manpower requirements of the helicopter operators, and in estimating the social services (roads, schools, sewage treatment plants, etc.) required by the local communities. The helicopter operators in the regions could also use such forecasts to plan for required increases in their fleets, the required capital investments, and the supply of trained pilots needed to satisfy the expected growth in their activities.

These envisioned uses of regional data to make regional forecasts hold promise of having even greater utility than national forecasts, which tend to submerge and obscure trends within the individual regions.

ANALYSIS OF CIVILIAN HELICOPTERS BY PRIMARY USE

The grouping of all helicopter activity into civilian and military operations, as was the case in this study, tends to obscure useful information which could be generated by analyzing helicopter demand by category of primary use, i.e., business and executive, personal, aerial application, instructional, rental, air taxi, and industrial.

The explanatory variables that can be related to the preceding sub-groups may be different from those that have been used to treat demand in the aggregate. For instance, "business and executive" use might possibly be explained by the number of large corporations with headquarters or major offices in large cities like New York, Chicago, and Houston. Similarly, "aerial application" can perhaps be explained in terms of the acreage of land that is sprayed with fertilizers and pesticides and the prices of the latter products.

The specific use categories can also be analyzed in conjunction with regional analysis. For instance, air taxi and business and executive uses are likely to be predominant in specific cities or Standard Metropolitan Statistical Areas (SMSA's), e.g. the Northeast Corridor, whereas "aerial applications" would be predominant in the Midwest.

DATA REQUIREMENTS AND AVAILABILITY

In order to analyze and forecast helicopter activity by region or by primary-use category, it is necessary to have an appropriate data base of helicopter activity as well as regional socio-economic data. The required data on helicopter activity in specific states and by primary use categories are available in several FAA publications, such as the Statistical Handbook of Aviation and the Census of U.S. Civil Aircraft. The required socioeconomic data are, however, not available as readily as required. Government organizations, such as the Bureau of the Census and the Bureau of Economic Analysis of the U.S. Department of Commerce, publish some socioeconomic data and forecasts, but there is a considerable time lag in publication. Hence, if the analyses and forecasts of helicopter activity are to be extended, it will be necessary to update and forecast the socio-economic data by states, SMSA's, cities and counties.

The FAA requirement to plan and forecast the workload of air traffic controllers as well as the facilities to support helicopter operations dictates the need for extensive capture of operational data, including such items as number of helicopters IFR-equipped, number of passengers carried (including crew), weight, average speeds, etc., both for piston-engine and turbine-engine helicopters. Traffic information required includes number of operations (takeoffs and landings), altitudes flown, and counts of terminal and enroute operations by region. These data are not available at present. Their availability to the FAA would contribute significantly to efficient planning for enroute and terminal facilities, to establishment of requirements for controllers and their training, and to the forecasting accuracy of helicopter activity.

MR. HENRY: Mr. Thompson is an Aviation Representative for the Ohio Department of Transportation, Division of Aviation. In this capacity, he developed a rotary wing aviation program for the State of Ohio. He participated in the establishment of public use heliports in Columbus and Toledo and other private heliports throughout the state. Mr. Thompson holds a Master of Science degree from the University of Southern California and a Bachelor's degree from Ohio State University. He is currently the chairman of the Helicopter Design and Development Committee and Vice President of the Ohio Helicopter Pilot's Association. He presented papers on heliport planning criteria and regulatory perspectives to the Monterey Conference on Planning for Rotorcraft and Commuter Transportation in 1981.

Today Mr. Thompson will draw on his vast experience in bringing you his viewpoints on helicopters and the local community. Ladies and Gentlemen, Mr. Jack Thompson.

HELICOPTERS AND THE LOCAL COMMUNITY

Jack L. Thompson
Aviation Representative
State of Ohio

SUMMARY

Mr. Thompson addresses the role that helicopters and heliports can play in serving the transportation needs of a community. He discusses the differences between airports and heliports and between fixed and rotary wing aircraft. Increased public awareness of those differences could lead to the playing of a greater role in serving the public's aviation needs.

INTRODUCTION

Thank you, Tom. First of all, I would like to convey greetings from my boss, Norm Crabtree, to the many people out there who I know are his friends, and also his regrets for not being here.

Secondly, I would like to acknowledge the contribution to my talk of a few people: Mr. Don Toller, Editor of Rotor & Wing International and Mr. Bill Paul, the Executive Vice President of Sikorsky, because, I had about 28 hours to prepare for this - including travel time and sleep. Both these gentlemen have given me liberty to paraphrase and otherwise plagiarize some of the things they have said to other groups. I hope I will be able to talk to you a little bit about what is going to be required in the way of interface between the helicopter industry and the local community.

I would suppose that someone from the State of Ohio was picked to talk about this subject because we have had a degree of success in incorporating public use heliports into our state transportation system. The fact - and I take a certain degree of pride in it - is that we have a public use heliport in the central business district of every major city in the state. When you consider that we have more major metropolitan areas than any other state in the country - the kind of cities where you don't have to say the name of the state in order to identify the city - that is a fairly significant statement. I wish I could take personal credit for some of those but I can't.

On the other hand, in many other cities around the country, notably Chicago, Los Angeles, Washington, D.C., Houston, San Francisco, Miami and many others, there is nothing that can really be called a public use heliport.

In New York City, where there are three commercially operated public use heliports, one of them suffers from its location, another is facing the stiff opposition of a local residential group, and the third submits to overcrowding at some hours of the day - indeed, they all suffer from that last problem.

That, essentially, is the situation today. Now, unlike Colonel Yates and Dr. Loret, I am neither an ex-fighter pilot nor a forecaster. Although, I am a helicopter pilot; I can tell you that. In order for the helicopter industry to reach its full potential and to reestablish the growth rate that it enjoyed prior to the current economic unpleasantness - and I use the word "current unpleasantness" in the same sense that Winston Churchill used it when he referred to World War II - it will be essential for the helicopter, as a transportation system, to be accepted into the urban environment of the future. Otherwise, it will be relegated to the hinterlands, the remote and offshore areas where it is currently operating, and it will never reach its full potential.

Most of you are involved in aviation to some extent and, as such, I am sure you have all read Tom Wolfe's book, "The Right Stuff." If you haven't, I would highly recommend it. I think it should be required reading for all people involved in aviation. In that book, Tom Wolfe talks about the early days of the fixed wing aircraft industry when it was popular to speak of barriers - the sound barrier, the thermal

barrier and so on; but those barriers marked more than just lines in a physics textbook, they were indicative of the efforts to cross those barriers, and indicative of an industry maturing, seeking to evolve beyond its adolescent years and to become a part of the establishment. It could be said that the helicopter industry is testing itself today against the heliport barrier. And if you haven't heard the sound of rotor blades knocking against the stone wall, it is only because the current international economic lethargy has thrown a massive wet blanket to muffle the noise.

In 1980, just before helicopter sales cooled off, the industry was beginning to advance out of the mountains, the farmers' fields, and the offshore oil patches of the world into the cities. Corporations finally had helicopters with twin engines that could offer comfort equal to any fixed wing aircraft. Rotorcraft were operating with economies that suddenly made those often tried and often failed helicopter airlines appear practical again.

Now this sudden buzz overhead did not go unnoticed, and citizens began to express their concerns about noise, safety and the quality of life. Many operators, in their fascination with the new machines, failed to notice the warning signs. The citizens were beginning to organize.

Several samples of public reaction to the heliport issue - positive, neutral, and negative - appear in Figure 1.

The situation in Houston, with which I'm sure a lot of you are probably familiar, is indicative of this problem with the local involvement in helicopters within communities.

At a time when the industry should be marshalling its public relations forces on the heliport issue, with the economy slowed down and helicopter sales having dropped off, there are fewer and softer voices calling out for downtown heliports right now. On the other hand, the special interest groups have kept on with their efforts in the zoning boards, fire departments, public hearings and so on and so forth, to make the development of heliports even more difficult.

However, like the sound barrier, if the right formula is followed, the obstacles can melt away. Knowing the formula is the trick, for it can be subtly different each time.

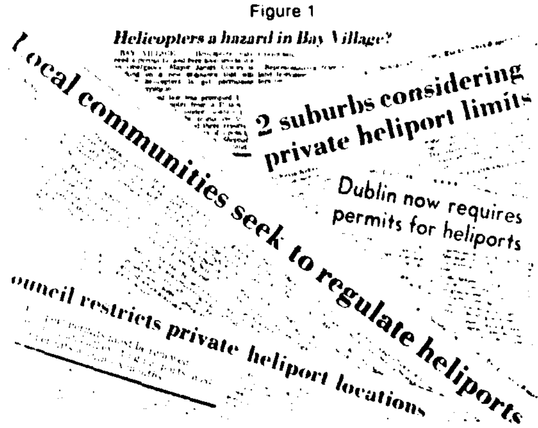
Now, looking at the problem of developing these heliports in a forecaster or a planning role, I think it might be helpful to know what these heliports are going to look like or what they should look like.

First, I don't want you to fall prey to the same rhetoric that was used by some of the opponents in Chicago of the Wolfe Point Heliport project. In the local paper, it was referred to as a commercial airport for helicopters. That was used, I'm sure, to influence the Chicago residents. They were supposed to envision some type of mini-O'Hare located right in the downtown area of Chicago. And, of course, you can imagine what kind of furor arose.

But talking about the posture between airports and heliports, bear in mind that heliports are not like airports when you talk about planning and that's primarily because helicopters are not like airplanes. The major difference, very simply, is that a helicopter stops and then lands as opposed to an airplane which lands and then stops. That's why the airplane needs the runway and the helicopter doesn't. And that, also, is the reason why helicopters can operate out of very close and confined areas such as downtown environments. This is really where the opposition to helicopters on a local level is starting to come about. The difference between airports and heliports I mean.

Airports have always been and still are, in most cases, located on the outskirts of town in open areas where relatively few people are impacted by the aircraft operations that are going on around them. Now suddenly, helicopters are, literally and figuratively, landing in people's back yards. In the city areas, the population density is high and many more people are feeling the impact of helicopter operations. They suddenly have started asking: "Hey, who's looking out for me in this case?" And this is what's bringing about this sudden rush of local ordinances (see Figure 1).

Figure 1



Landing helicopters on airport runways defeats the very purposes why helicopters (and runways for that matter) were developed in the first place. But on the other hand, heliports or at least access for helicopters at airports are necessary to provide the needed interface between commercial carriers and the rotorcraft transportation system.

The primary goal, however, when we are talking about heliports, is the all weather heliport in the metropolitan area, where we are asked to guarantee assured schedule reliability under severe IFR weather conditions. Helicopters will be required to connect passengers with other modes of transportation which already operate in all types of weather, including airplanes.

Here's another little point to bear in mind. It helps sometimes when you think that heli-

copters are really an alternative to ground transportation. I like to refer to it as the ultimate all-terrain vehicle. It can travel from point A to point B in a straight line at very high speeds, without regard to any obstacle, whether permanent or temporary, like mountains and trees or snow banks and floods. Getting back to the subject of downtown heliports, metropolitan heliports do not necessarily have to be located in the middle of the city, but they must have access to city center and other transportation facilities. Now, there are several design criteria that are currently under development by the Helicopter Association International. Things that must be considered include: size, adjacent air space, acceptable level of environmental noise impact, suitable obstacle clearance, real estate for emergency landings, navigation systems, lighting coverage, and operating locations that do not interfere with other established modes of transportation. The performance of the IFR helicopter that will use a heliport developed under these criteria must also be a major consideration.

As you can see, design is very important, particularly in the downtown area where real estate is very expensive. If the helicopter has high performance at low speeds, then the heliport can be smaller and less expensive to develop. However, all types of heliports are practical depending on their location. They can be located near a river, such as those in New York City, or on roof tops. And, of course, you have parking garage heliports similar to the ones opened in Cincinnati, Toledo, and Detroit in the last 3 or 4 years. In some areas, designers are even putting them on barges in rivers, for example, in St. Louis and London, England.

The point is that heliports can be located almost anywhere once certain criteria are met. Airports, on the other hand, can only be located in large areas away from the center of commerce. Could you imagine what it would cost to buy the land on which LAX (Los Angeles International Airport) is located today? Of course, the advantages of having a heliport in or near the center of town can help the city itself. It provides landing locations for police and medical emergencies, and it is a source of revenue for the city from landing fees. And, by far not the least of the contributions, the heliport can serve as an attraction for businesses that use helicopters to relocate to the city.

Heliport facilities will include appropriate lighting and parking areas, terminal buildings, fueling and emergency equipment, as well as all weather facilities such as de-icing equipment, weather stations, and NAV-COM and ATC equipment.

One of the major obstacles to heliport development is noise. It is not that helicopters are extremely noisy; it is that their noise is sufficiently different that most people, including those who plan and develop local planning and zoning ordinances, do not understand it. To stand up before a public hearing and explain that helicopters are really not noisy has very little impact. The members of the audience just don't want to be confused with the facts. They have already made up their minds, and that is a situation that we are facing constantly, every time we get involved in the construction of heliports.

Local noise ordinances foster unrealistic acoustic criteria, characterized by excessive simplified single maximum acceptable noise levels, without regard to ambient noise levels. Now, the Helicopter Association International's Acoustics Committee has developed an acoustical guideline that, we hope, will be incorporated into both the HAI and, also, Federal and State regulatory efforts. Its implementation will defuse and disarm those people who are interested, uniformedly, in trying to regulate heliports out of existence using noise as a weapon.

Furthermore, at the instigation of the American Helicopter Association, NASA has initiated and funded a 10 million dollar, 5 year project, with the active participation of both the FAA and the HAI. The long term goal is to reduce significantly the rotorcraft noise problem through technological research and development. At the same time, on a short term level, the industry has initiated and administered, through the HAI, the "Fly Neighborly Program." The purpose is to change or re-orient the attitudes of operators in the way that they fly their aircraft in order to reduce the acoustical impact on the environment, and, at the same time, to increase the awareness of the public of the humanitarian, social and economic benefits and opportunities that can occur from the use of helicopters and the development of heliports within their communities.

To sum up, in Thomas Wolfe's book "The Right Stuff," jet pilots, observing the remains of an aircraft accident, always viewed it as coming from some individual problem of the doomed aircraft's pilot and always ended up by saying that it would never happen to them. Many of us in the helicopter industry have believed the situation in Houston and Chicago to be problems of just the local operators and really none of our concern. In these slow economic times, however, it might be wise to remember that the fate of the helicopter industry, as a whole, is dependent on the success of its parts. In many ways, the future of the two segments of the helicopter community - corporate operations and scheduled airlines, not to mention air taxi services - is dependent on the industry's breaking that heliport barrier.

Thank you.

MR. HENRY: Mr. David Lawrence is Director of Strategic Planning, United Technologies-Sikorsky Aircraft, Stamford, Connecticut. He assumed this position in 1981. In this capacity, Mr. Lawrence has direct responsibility for formulating the division's over all strategic objectives and for coordinating related business and technical planning. In particular, he is responsible for the analysis of future markets for helicopters and for the business environment in which his company can expect to operate. As such, he is concerned with the economic outlook for industries that use heliports. Mr. Lawrence joined Sikorsky in 1957. He held several supervisory positions before becoming a Senior Economic Analyst in 1968. Since then, he has held management positions in operations analysis and business planning. He also served for four years as an officer in the United States Navy. The Newark, New Jersey native holds a Bachelor of Arts degree in economics from Syracuse University and a Masters degree in economics from the University of Bridgeport. He has written a number of papers and articles on aviation economics and has taught economics at colleges in southern Connecticut. Mr. Lawrence is eminently qualified to present to you the outlook for helicopter activities during the 1983 - 1994 period. Mr. Lawrence.

THE OUTLOOK FOR CIVIL HELICOPTERS 1983/1994

David S. Lawrence
Director, Strategic Planning
Sikorsky Aircraft

SUMMARY

Mr. Lawrence points out the difficulties of forecasting helicopter activity because of the lack of data, the absence of conventional definitions, and the relative unimportance of helicopters when compared to the rest of the aerospace industry. Nevertheless, Mr. Lawrence has developed a forecasting model that he calls a segmented farrago. His method involves subdividing the marketplace into the smallest justifiable cells, applying an appropriate forecast method to each cell, adding up the separate forecasts, and using judgement to smooth over inconsistencies.

INTRODUCTION

I appreciate the opportunity to comment on the outlook for civil helicopters, particularly since we have been the most vocal critic of previous attempts to forecast this business. In fact, I assume there is some connection between our earlier criticism and this invitation; and I think that this is not just getting even on Harvey's part, but a very constructive way to approach the problem. Forecasts are always conjectural and controversial. Even the prediction of sunset at 5:55 this afternoon needs a little qualification, and anything less predictable than the sunset will attract lots of discussion. So I think the consensus approach that Tom Henry has organized today is clearly the best way to go about it. I should add that I was asked to address either the outlook or the method, but found it impossible to discuss one without the other. And finally, any discussion of civil helicopters in the United States has to be seen in the context of worldwide military and civil helicopter growth and to that end I will touch on those areas briefly before getting down to specifics.

By way of explaining why there is so much controversy about helicopter forecasts, I must point out that there are problems associated with this sector of the aerospace business that our fixed-wing big brothers largely escape. The first problem is the paucity of data. Helicopters don't have their own three-digit Standard Industrial Classification, so we can't track our business the way the rest of aerospace can. Moreover, most helicopter manufacturers are divisions of larger conglomerates, and their divisional financial data are not generally published. For example, my own company is the largest helicopter manufacturer in the world, but only a division of United Technologies; and we account for only about 7 percent of our parent's sales and overall employment. And then, helicopters hardly ever use fixed-wing airports. This is good because it helps to define the unique characteristic that has made the helicopter valuable in our transportation system; but it is also bad because most helicopter operations take place beyond the purview of FAA towers and thus don't show up in the data bank.

The second problem is that the few data we have are very poor data. The reporting system, such as it is, allows a great latitude, and there are enormous gaps. This is compounded by a definitional problem when we try to sort out the civil market, typified by the Bell UH-1 helicopter, which may be exported as a UH-1 or as a B-205, with little clue as to military or civil use.

Finally, the helicopter business is a very small share of aerospace. Bear in mind that the worldwide employment in our business is only about 50,000 people. We could all fit in one of McDonnell's hangars. Because of our small chunk of aerospace, sizeable helicopter deals have been done as an offset to some much larger

fixed-wing deals. The dangers of extrapolating recent sales to future sales are characterized by this kind of statistical noise, which results in very low levels of confidence in the outcome.

Having now told you how difficult it is to forecast helicopter activity, let me review some of the techniques people have used in the past.

Most helicopter forecasting has been trended, mostly by people who don't understand the helicopter business but have been directed to produce a forecast. Recognizing the lack of decent helicopter data to trend, some forecasters have implicitly assumed that helicopters were part of something else on which there was good data. The FAA's 1980 forecast, for example, assumed that helicopters were a consistent subset of general aviation aircraft, and helicopter activity was projected as a constant percentage of the G.A. forecast. In fairness I have to point out that the people in the FAA who do this are as sharp as anyone in the business. But there are times when you need a working number in a hurry, and this method of producing one was no more bizarre than lots of others.

The kind of forecasting that manufacturers have favored over the years is essentially bottom-up. This can be accomplished in a number of ways. One might add all the likely demands for helicopters in a market-by-market analysis. An alternative might impute to the manufacturers a lot more intelligence than they have by adding up what they claim to be producing for whatever sales they believe are out there.

And then, inevitably, there is the econometric approach, and this is the approach favored by many outside consultants, including ASI in some recent work for the FAA. Our problem with the econometric approach has to do with the volume and quality of the data on which the equations are based, for the reasons I identified earlier. It is exacerbated by the number of different roles the helicopter can play and the absence of a reliable data collector for each of those roles. You might try to model each role separately by artificially disaggregating the available generic data, but that just breaks up an already muddied stream into individual pools of badly polluted data. These problems have led econometricians to force one universal model with an enormous array of increasingly incredible surrogates for the missing data. Thus, their output can boast of high correlation coefficients -- as well as lots of multicollinearity and very little confidence.

The last approach is what I called the "segmented farrago," and this is what we used at Sikorsky. It means simply that we divide the marketplace into the smallest cells we can justify and then approach each cell eclectically with a forecasting method appropriate to the data available, the expertise of our analysts, and our own experience. This means that we may use any of these approaches on a micro basis and then add them up and resolve discontinuities judgementally. In defense of this seemingly disorderly method, it works. I might add that we've been using this inelegant segmented approach for several years now, and the logic is very powerful.

With that insight into our arcane methodology, let me get to the output, and I'll start out by comparing the last decade to the next decade (see Figure 1). Between 1973 and 1982, 19,000 new helicopters were delivered by the world's manufacturers. We project that 24,000 units will be delivered between 1983 and 1992, for an increase of about 26 percent overall. While I won't be talking about manufacturers' revenues, which is a whole different set of forecasting problems as you can well imagine, I will observe that the average real cost of a helicopter will increase by about 50 percent from a million dollars in the last decade to a million and a half in the next. This is of course driven by the military requirements.

We can look at a simple breakdown of these helicopter deliveries, considering only two markets -- the U.S. and the rest-of-the-world, and two uses -- military and civil. The U.S. civil component of the last decade's helicopter deliveries was 32 percent of the total, and we

Figure 1

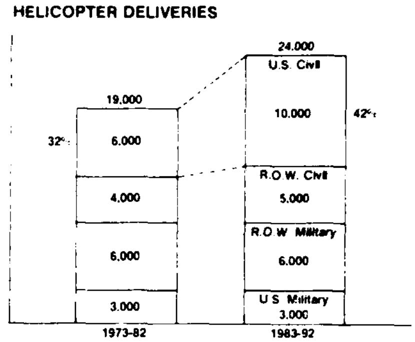


Figure 2

12-YEAR PROJECTION FOR CIVIL HELICOPTERS

	Light	Intermediate	Medium	Heavy	Total
U.S.	10,400	1,400	200	6	12,000
R.O.W.	4,500	1,500	500	9	6,500

expect this to increase by 4,000 units to 42 percent in the next decade. This is reflective of a worldwide trend in which civil helicopters generally will increase their share of worldwide production from 53 percent to 63 percent.

The U.S. civil marketplace thus will grow by two-thirds between the last decade and the next, with an average annual growth rate of about 5-1/2 percent for the 20-year period, which is not significantly out of line with the world market. I might point out that this growth is accompanied by about 30 percent increase in the price of the average civil helicopter in real terms, which primarily indicates a fleeting-up of the inventory from light single-engine aircraft to heavier twin-engine aircraft with more advanced flight systems. This is a significant trend, because it identifies the civil helicopter as a product that even now is not fully matured. Evolving technology brings with it a continuing product differentiation that in turn provides an extra bit of stimulus to drive the market faster than GNP. The helicopter industry still enjoys that stimulus. Its growth is due in part to tomorrow's helicopter being significantly better than yesterday's, and next year's being significantly better than this year's, and on into the nineties. And by "better," of course, I mean more efficient, more comfortable, faster and safer. Let me now accommodate the ground rules of this conference by expanding the forecast period to 1994 and increasing the projection to 12,000 U.S. civil helicopters. I can tell you that that revision is every bit as sophisticated as it looks, because we can't see 1993 and 1994 clearly enough to do anything more than ratio the numbers on the assumption that all the conditions of the forecast will continue.

We find it convenient to divide the market into four classes by helicopter weight: those below 6,000 pounds gross weight, which we call light (and which, by the way, exclude piston-engine helicopters); then those between 6,000 and 15,000 pounds, which we call intermediate helicopters; those between 15,000 and 35,000 pounds, which we call medium; and finally, those above 35,000 pounds, which we call heavy. Our projection for the U.S. civil marketplace is nearly double what we forecast for the rest of the world, largely because of the surprising continued proliferation of light helicopters in this country. My intention is to review these weight classes one at a time (see Figure 2).

Light helicopters are typified by the Bell 206 and its competition, predominantly from Hughes and Aerospatiale. Until recently these were the only helicopters that were affordable by users other than governments or large corporations. They are characterized by an acute sensitivity to economic conditions, which have affected them significantly during the last two years and will continue to do so, since the return of the helicopter business is certain to lag behind the economic recovery by three to six quarters. We assume in our forecast a continued drift from single-engine helicopters to twins, and the difficulty of amortizing the second engine's cost over the productivity of a light aircraft makes it likely that this weight class will lose business to heavier helicopters. Another factor that influences us is the absence on the horizon of military programs in this weight class that will benefit the civil market in any meaningful way. The military outlook involves technology requirements with price tags that won't fit the cost/productivity requirements of light helicopters.

We do feel that smaller helicopters can be -- and increasingly will be -- designed specifically for the civil market by the world's manufacturers, while helicopters larger than 15,000 pounds cannot be developed by the private sector and must continue to rest heavily, even totally, on military development. So this weight class is dependent on the private sector for further advances, and we don't see much in the way of substantive innovation in the next few years.

Our forecast for light helicopters is a little more bullish than some others; and it may be that the tea leaves look different to some of our competitors who are more active in that weight class than Sikorsky is, at least at this time.

Most of the strength in this class will continue to rest in the corporate and utility markets. We see it weakening in offshore oil as the offshore service industry increasingly depends on twin-engine reliability, because there are diseconomies in twinning light helicopters, as I suggested a moment ago (although Bell has apparently decided to twin the Jet Ranger). The overall growth rate in the class should average 5 percent per year.

Intermediate helicopters are those between 6,000 and 15,000 pounds gross weight, typified by our S-76 Mark II, and by the Bell 222 and Aerospatiale SA 365, as well as older technology helicopters that continue in production.

This weight class is also somewhat sensitive to the economy, although not nearly so sensitive as are the light helicopters. These are closely linked to offshore oil, to the extent that their fortunes (until recently) seemed independent of the problems in other markets.

We have assumed, on the basis of slim evidence but strong parametrics and a lot of good will, the likelihood that the helicopter taxi market will be re-established during the next twelve years. One reason for our optimism is that there has been a significant technology fall-out into this weight class from heavier military aircraft, and we project that this will accelerate, showing up largely as lower costs and higher productivity. We look for an overall average growth rate in the intermediate weight class of about 7 percent per year, significantly greater than in the light weight class, though building on a smaller base. The strength of this class should shift slowly from offshore oil to the corporate sector, which will make it more sensitive to the economy in the out years.

Medium helicopters as we define them include the S-61 transport now under re-development by Agusta and also the Bell 214ST and the Aerospatiale SA 332. These are work horses in the offshore service market but have been only marginally successful in other areas. Civil helicopters in this class are all derivatives of military predecessors. Large helicopters, by virtue of their cost and complexity, have very small unit markets; and it isn't practicable for a manufacturer to design and develop a civil vehicle on his own. Consequently there has never been, and probably never will be, a medium helicopter that is ideally suited to commercial operations, and operators are often faced with equipment solutions that are suboptimal. With this as background, we look for an average annual growth rate of only 3-1/2 percent, and total deliveries of about 200 aircraft into the U.S. civil market between 1983 and 1994. We do see continued strength in the offshore sector, and airlines in some form are a possibility for the out years.

It is no secret that my company has been evaluating the market for a new medium transport for some time with the thought of developing a civil relative of the Black Hawk helicopter we now produce for the U.S. military. Frankly, it has been difficult to see a market large enough to justify a go-ahead, but we continue to assess this market.

Once again please note that the heavier the aircraft, the smaller its market. It will come as no surprise as we address heavy helicopters in the civil market (which includes only the Boeing Vertol 234) that we see no growth during the forecast period. We can't identify specific requirements, but we have included a token production quantity in acknowledgment of a number of interesting possibilities.

Before I summarize, I would like to address a couple of anomalies that influence our forecast. On the negative side we have included very little new production for the so-called utility markets, which include logistics work and miscellaneous lifting jobs that are difficult to classify. Utility operators tend to use older aircraft that have been displaced from primary markets by the advent of new technology. Thus they do not drive procurement. They are also most sensitive to the economy in that they are the swing markets in recession but not in recovery, and they are vulnerable in bad times to non-helicopter alternatives.

A caution in our forecast has to do with offshore helicopters generally. These are largely international in nature and thus have less effect than we might expect on the U.S. market. Modelling this sector is very chancy because procurement decisions are dominated by the oil companies themselves rather than by the charter operators, and factors other than low cost and productivity sometimes predominate. I will also admit that the recent collapse of the offshore helicopter market in the face of pervasive high interest rates and the declining price of oil was not projected by any of us early enough to do much about it.

On the positive side I believe we have all underestimated the ability and willingness of American corporations to buy helicopters for general business use, and that the return of industrial production and corporate profits will presage strong substantive growth in that sector. Also on the positive side (but with some caution) we do look for a re-emergence of the helicopter taxi business in downtown-to-airport route systems in a number of major metropolitan areas. Every forecast must have its caveats. First, of course, are the overall economic assumptions on which all business forecasts rest. My projections implicitly assume a modest economic recovery late this year and relative stability through the remainder of the period. Economic shocks would act very quickly, if impermanently, on this still somewhat discretionary helicopter market; and instability in domestic financial markets and the escalation of tensions in the international oil community are always lurking in the wings.

A second caveat is air traffic, which could work in opposite direction to us. Increases in fixed-wing congestion have historically accelerated the use of off-airport helicopters, and will continue to do so. On the other hand too-rapid growth in helicopter traffic itself would tend to weaken the potential of future markets. Thus we are very concerned about the development of the infrastructure needed to support orderly growth in the helicopter market. Without going into details on the key components of the infrastructure -- which will continue to be discussed in other forums -- let me at least name for you the growing need for all-weather heliports and dedicated airways, and the problems of regulating helicopters within the aviation and urban communities.

In summary, the outlook for civil helicopter deliveries in this country is upbeat for the 12-year forecast period, if a little sluggish at the start. For the next two years we'll limp along with the rest of you behind the economic hockey stick; but basic requirements don't go away, and the release of latent demand should give us a growth spurt in 1984. The early part of this growth will rapidly drive up the utilization of presently idle equipment while manufacturers' delivery rates very slowly creep back to their 1980 levels. During the next few years the line between domestic and international helicopter sales will blur somewhat, reflecting the increasingly mulitnational character of the manufacturers as well as their customers.

In the longer term, we see real growth averaging 5-1/2 percent, with the next decade's helicopter deliveries about two-thirds greater than the last one's. The offshore service business, which drove helicopter sales in the last decade, will slowly yield its leadership to the business jet market, which will be our growth engine of the 80's.

The increase in average real unit cost, as I have suggested, reflects a growing preference for larger helicopters and more sophistication. Implicit in that are fleet-wide improvements in power, payload, reliability, and all-weather capabilities.

It is that thrust, even more than the dramatic increase in deliveries, that defines the personality of the eighties' helicopter business. The difference between ten years ago and ten years from now is the emergence of the civil helicopter from military surplus to its key role in national transportation. This evolution is fun for us, and I thank you for letting me share it with you this afternoon.

MR. HENRY: Thank you very much, Dave. We will now entertain questions from the audience if there are any... Please state your name, affiliation, and to whom the question is addressed.

MR. GOREM: I am Jim Gorem of Jim Gorem Associates. The question is addressed to David Lawrence of Sikorsky. You did not mention at all the tilt rotor concept which Bell has been developing. Any views on that prospect?

MR. LAWRENCE: We were thinking of entering that as a JVX candidate, but at the last minute we decided not to. If you would like me to address the tilt rotor I will. It's a very interesting design. If it works out at the substantially increased gross weight that the manufacturers have in mind, it could certainly be a very interesting transport for the 90's. I don't think there is any question about that. I mentioned before that as aircraft get bigger, as helicopters get bigger, their unit sales get smaller. And one of the reasons that we may not be nearly as excited about that kind of vehicle as Bell and Boeing have been, is that it is hard to find a commercial market for it. I've had some difficulty understanding exactly where it would be used and under what circumstances, and whether or not those uses would justify enough aircraft to make it prudent for a manufacturer to jump in. Bell obviously has done the same arithmetic and come up with different answers. And one of us is clearly wrong.

As you know, we tend to favor high speed helicopters, our ABC candidate, which is really a helicopter and is subject to the limitations of helicopters. We are not in the fixed wing business and we think that the jump to a tilt rotor gets us into a kind of fixed wing business that perhaps we don't understand enough. Perhaps we are not ready to make a jump of technology and a capital investment of that magnitude for a market that, frankly, looks a little bit marginal.

I did not address the military aspects, but that is a whole other chapter as you know. We have had news releases in the last few days that I'm sure will cover that.

MR. HENRY: Any more questions?

MR. CHRISTIANSEN: My name is Henry Christiansen, FAA Southwest Region. In view of David Lawrence's comments on the need for dedicated airways and all weather heliports, and also Mr. Loret's comments on recommending a regional forecast, it would seem that a regional forecast would be required in making much progress in getting dedicated airways and all weather heliports. I'm curious what FAA's plans are to pursue the development of regional forecasts.

MR. HENRY: Well, I'd like to be able to give a response to that, but I notice that Mr. Mercer and Mr. Zywokarte are in the audience and they, probably, have more to say in what is going to happen in that respect than I. I defer to them if either of them would like to respond.

MR. MERCER: We do have it in our work program for this year. We will begin work on a regional forecast model for helicopters. That should be probably a year away before we come out with any particular results from that particular work. It is going to be an outside study because we do not have the manpower to devote to it.

MR. HENRY: Any more questions?

(No response.) It seems as if we are coming to the conclusion for the day. Before I leave the podium, let me extend an invitation. Mr. Barney Hannon, over there, has offered to take me to National Airport and show me what a helicopter looks like and if anyone wants to join me, he is welcome to do so. Thank you.

MR. MERCER: Thank you for coming. It has been a long, long day but I am sure you have enjoyed it as much as I have. We do have a few messages on the bulletin board and there was a gentleman who took notes all morning long and somebody inadvertently picked them up. If anyone finds them please leave them at the front desk.

Other than that, see you all next year.

Helicopters. The interpretation is as follows: equation.